A Dissertation on

STUDY OF LEFT RENAL VEIN, ITS ANATOMY, VARIATIONS AND ITS CLINICAL SIGNIFICANCE

Submitted for

M.D. ANATOMY

BRANCH - XXIII

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY
CHENNAI – 600032.

APRIL 2015

CERTIFICATE BY INSTITUTION

This is to certify that **Dr. SASI KRISHNAN.G,** Post - Graduate Student (MAY 2012 TO APRIL 2015) in the Department of Anatomy STANLEY MEDICAL COLLEGE, Chennai- 600 001, has done this dissertation on "**A STUDY OF LEFT RENAL VEIN, ITS ANATOMY, VARIATIONS AND ITS CLINICAL SIGNIFICANCE AT DEPT OF ANATOMY, STANLEY MEDICAL COLLEGE, CHENNAI – 600001"** under my guidance and supervision in partial fulfillment of the regulations laid down by the Tamilnadu Dr.M.G.R. Medical University, Chennai, for M.D. (Anatomy), Degree Examination to be held in April 2015.

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CERTIFICATE BY GUIDE

This is to certify that **Dr. SASI KRISHNAN.G,** Post - Graduate Student (MAY 2012 TO APRIL 2015) in the Department of Anatomy STANLEY MEDICAL COLLEGE, Chennai- 600 001, has done this dissertation on "**A STUDY OF LEFT RENAL VEIN, ITS ANATOMY, VARIATIONS AND ITS CLINICAL SIGNIFICANCE AT DEPT OF ANATOMY, STANLEY MEDICAL COLLEGE, CHENNAI – 600001"** under my guidance and supervision in partial fulfillment of the regulations laid down by the Tamilnadu Dr.M.G.R. Medical University, Chennai, for M.D. (Anatomy), Degree Examination to be held in April 2015.

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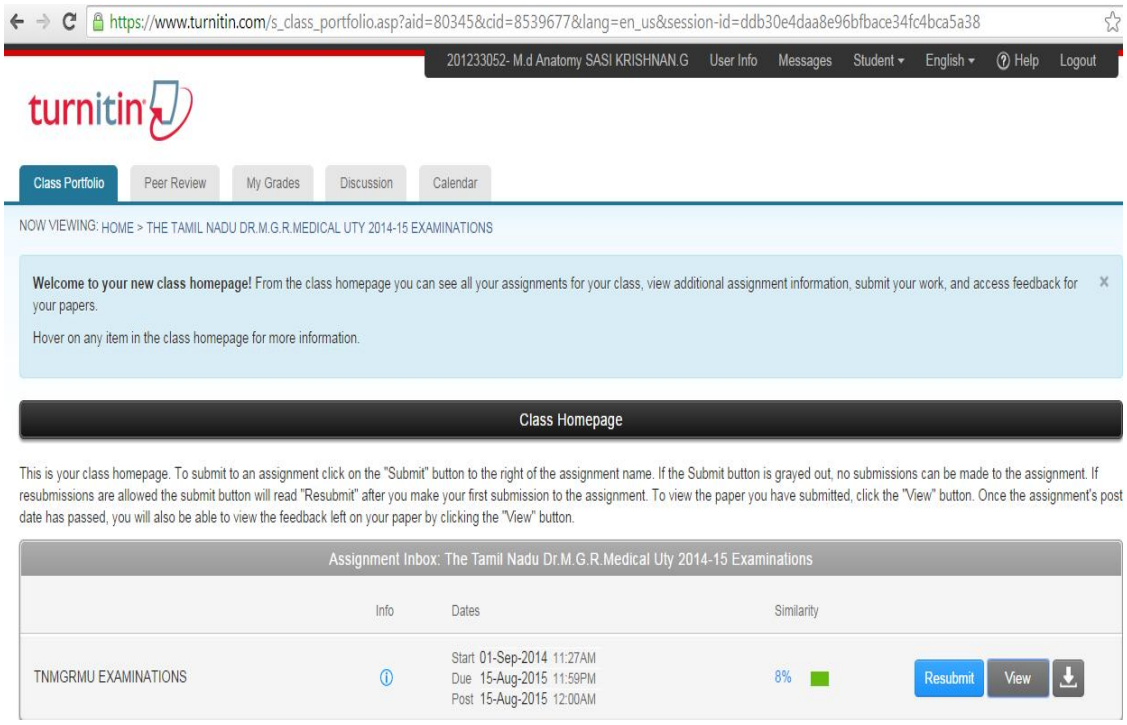
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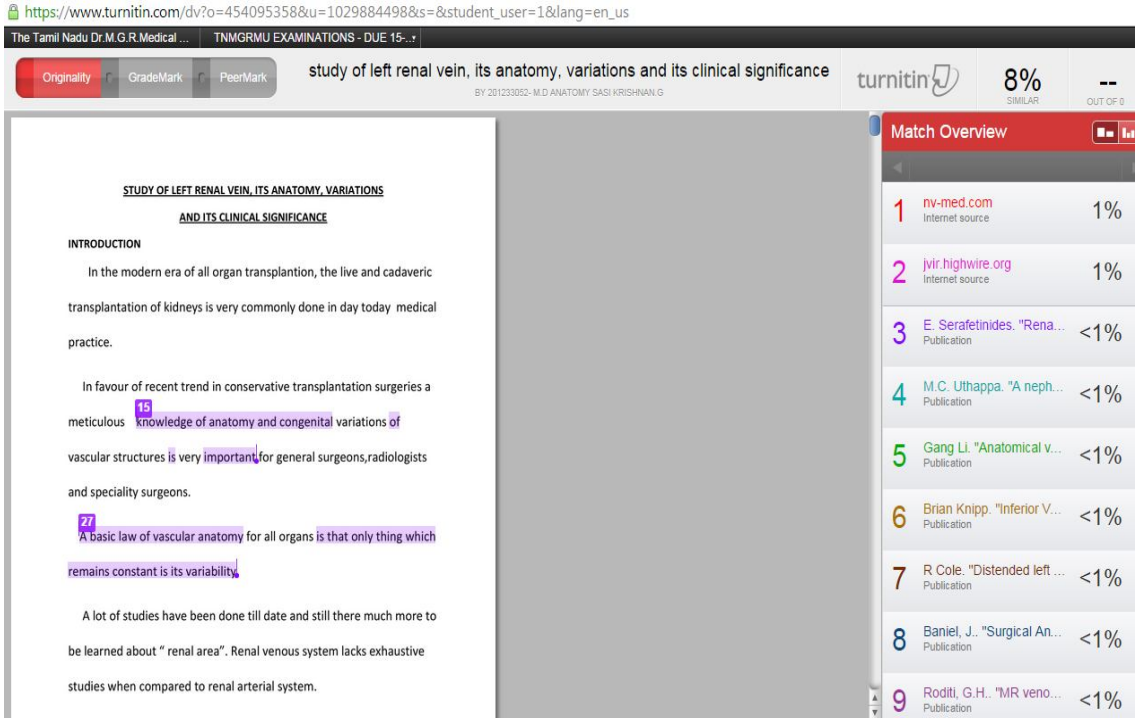
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STUDY OF LEFT RENAL VEIN, ITS ANATOMY, VARIATIONS
AND ITS CLINICAL SIGNIFICANCE
INTRODUCTION
In the modern era of all organ transplantion, the live and cadaveric transplantation of kidneys is very commonly done in day today medical practice.
In favour of recent trend in conservative transplantation surgeries a meticulous knowledge of anatomy and congenital variations of vascular structures is very important for general surgeons,radiologists and speciality surgeons.
A basic law of vascular anatomy for all organs is that only thing which remains constant is its variability.
A lot of studies have been done till date and still there much more to be learned about " renal area". Renal venous system lacks exhaustive studies when compared to renal arterial system.
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DECLARATION

I **Dr. SASI KRISHNAN.G** declare that I carried out this work on "**A STUDY OF LEFT RENAL VEIN, ITS ANATOMY, VARIATIONS AND ITS CLINICAL SIGNIFICANCE AT STANLEY MEDICAL COLLEGE, CHENNAI - 600001**" at the Department of Anatomy during the period AUGUST 2012 to AUGUST 2014. I also declare that this bonafide work or a part of this work was not submitted by me or any other for any award, degree, or diploma to any other university, board either in India or abroad.

This is submitted to The TamilnaduDr.M.G.R. Medical University, Chennai in partial fulfilment of the rules and regulation for the M. D. Degree examination in Anatomy.

DR. SASI KRISHNAN.G

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At the outset I thank our Dean, **.Dr.AL.MEENAKSHI SUNDARAM. M.D, D.A** for permitting me to carry out this study in our hospital.

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I immensely thank **Dr.C.AMARNATH, M.D(RD).,** Professor Of Radiology and **DR.V. MURUGESAN M.D,** Professor of Forensic medicine for their constant guidance throughout the study.

I wish to Thank my Associate and Assistant Professors of my Department of Anatomy, Stanley medical college, for their valuable suggestions, encouragement and advice.

I sincerely thank the members of Institutional Ethical Committee, Stanley Medical College for approving my dissertation topic.

I thank all my Colleagues, seniors, and Staff members of my Department for their support.

CONTENTS

ABSTRACT

TITLE: STUDY OF LEFT RENAL VEIN, ITS ANATOMY, VARIATIONS AND ITS CLINICAL SIGNIFICANCE.

AUTHOR: DR.SASI RISHNAN.G, IIIYR POSTGRADUATE IN DEPARTMENT OF ANATOMY.

GUIDE: DR.S.CHITRA, PROFESSOR & HOD, DEPARTMENT OF ANATOMY,STANLEY MEDICAL COLLEGE, CHENNAI.

AIM OF STUDY: TO STUDY THE ANATOMY (MORPHOLOGICAL & MORPHOMETRIC)

PARAMETERS, VARIATIONS AND ITS CLINICAL SIGNIFICANCE OF LEFT RENAL VEIN.

MATERIALS AND METHODS: DISSECTION METHOD, 22 CADAVERS AND 8 ENBLOC SPECIMENS, RADIOLOGICAL METHOD, MULTIDETECTOR CT IMAGES FROM 20 PATIENTS.

RESULTS: VARIOUS OBSERVATIONS THAT ARE NOTICED WERE COMPILED AND COMPARED WITH THE PREVIOUS STUDIES. THE INCIDENCE OF CIRCUMAORTIC AND RETROAORTIC LEFT RENAL VEIN COINCIDES WITH MOST OF THE PREVIOUS AUTHORS STUDY, EXCEPT FOR SATYAPAL'S.

KEY WORDS: LEFT RENAL VEIN, CIRCUMAORTIC, RETROAORTIC, VENOUS COLLAR.

NUT CRACKER PHENOMENON, LEFT RENAL VEIN LIGATION.

STUDY OF LEFT RENAL VEIN, ITS ANATOMY, VARIATIONS

AND ITS CLINICAL SIGNIFICANCE

INTRODUCTION & AIM OF STUDY

In the modern era of all organ transplantion, the live and cadaveric transplantation of kidneys is very commonly done in day today medical practice.

In favour of recent trend in conservative transplantation surgeries a meticulous knowledge of anatomy and congenital variations of vascular structures is very important for general surgeons, radiologists and speciality surgeons.

A basic law of vascular anatomy for all organs is that only thing which remains constant is its variability.

A lot of studies have been done till date and still there is much more to be learned about " renal area". Renal venous system lacks exhaustive studies when compared to renal arterial system.

Left kidney & left renal artery/ vein is the preferred and favoured side for donor nephrectomies to the renal transplant surgeons.

So left renal rein is very important,

As a surgical landmark for the vascular surgeons in abdominal aortic surgeries,

As a diagnostic tool for radiologists where variations of left renal vein do occur,

As a cause for renovascular hypertension (in nut cracker phenomenon, and renal vein thrombosis) in medicine due it its abnormal course, &

As a cause for pelvic congestion syndrome in obstetrics & gynaecology.

Anatomically the variations of left renal vein may occur, in its formation,

In aberrancy ,

In tribuitaries,

In communications and

Its course across the aorta to Inferior vena cava.

The variations may also occur in its length and diameter.

When compared to right renal vein which lacks all these features except for the fact that accessory renal veins are quite frequent on the right side.

So the purpose of present study is

To describe and discuss the variations on the basis of their occurrence

Range of variations in pattern and dimensions (morphological & morphometric)

Striking curiosities which depart from the anatomic norm in a graded series as, Based on the following parameters,

1. Pattern of confluence of tributaries forming left renal vein.
2. Incidence of retropelvic venous tributary/vein forming left renal vein.
3. Mode of termination of left suprarenal and inferior phrenic veins in relation to left renal vein.
4. Mode of termination of left gonadal vein in to left renal vein.
5. Relation of termination of left common trunk to left gonadal vein in reference to left renal vein.

6. Distance of point of termination of left suprarenal/ common trunk from left margin of IVC.
7. Relation of left renal artery to left renal vein.
8. Incidence of left renal vein variants.
9. Length of left and right renal veins.
10. Angle formed between the left renal vein and inferior vena cava

ANATOMICAL REVIEW OF LITERATURE

Renal venous system, a part of retroperitoneal venous channels attracted anatomists from as early as 2 centuary AD, when Galen mentioned Renal veins.

RUPERT, (1913)[87] gave an incidence of 18 out of 50 for retropelvic venous tributary to left renal vein. (36%), and retroaortic left renal vein as 3, circumaortic as 6, left gonadal artery hooking over left renal vein as 1.

EISENDRATH, (1920)[27] gave an incidence of 201 out of 218 (92.2%) to have either a retropelvic venous tributary / vein of which 86.2% had an artery accompanying it, and also observed left renal vein formed from equal sized anterior and posterior tributary in 3 out of 218 kidneys studied (1.3%).

SEIB G.A (1934)[92] named the retroaortic limb of circumaortic venous collar as retroaortic renocaval arch. From 186 specimens he found 1 left post renal inferior vena cava connecting left common iliac and left renal vein.

J.ERNEST FRAZER, REGINALD.H et al (1937)[31] described left renal vein as preaortic and left inferior phrenic and left suprarenal and gonadal veins all drain into left renal vein.

PICK. J. W., & B.J. ANSON, (1940)[76] frown an anatomical study of renal vascular pedicel in 430 body halves had given illustrative description of a spectrum of variations as follows:

I. A single left renal vein formed by confluence of 2 large hilar tributaries.

II. Circumaortic left renal: preaortic segment formed by conjunction ot 3 hilar tributaries: proximal to Junction of the lowest tributary, 2 spermatie veins entered and distal there to the single left suprarenal vein, around the latter left spermatic artery hooked.

III. A main left renal vein and a smaller one join to form a common channel before entering IVC, between the 2, passed an anastomotic vessel which formed lateral boundary of a venous hiatus transmitting letft spermatic artery.

IV. A single retroaortic left renal vein with a suprarenal and inferior phrenic jointly entered it cranially; internal spermatic and polar tributaries forming common channel entered caudally.

V. One large left renal vein superiorly received a single suprarenal vein.

BARRY J. ANSON PH.D., EARL W. CAULDWELL, M.D., et al., (1947)[6] studied 400 cadavers and observed the following :

Renal vein of 'standard' type

Rarely duplication of left renal vein.

Division of single left renal vein, en route to IVC, surrounding aorta forming circumaortic ring was commonly noticed.

As it splits. one limb passes in front of aorta. other obliquely downward behind aorta to IVC,outlining a triangular space.

Left renal vein in addition to receiving visceral tributaries from the suprarenal and gonadal also received dorsally placed somatic veins of lumbar series.

With respect to suprarenal vein they observed, left vein longer than right, almost always receiving inferior phrenic vein reached left renal Vein opposite the termination of the left internal spcrmatie vein.

BARRY J. ANSON, Ph.D., and LE ROY E. KURTH, M.D., (1955)[8] from their study of left renal vein in 33 specimens observed the following:

Left suprarenal and left inferior phrenic confluence	- 25
left gonadal and 2nd lumbar	- 1
left gonadal and left suprarenal	- 1
Communication with lumbar veins	- 25

HILEL NOTKOVICH, M.D., (1956)[47] based on his work on 183 cadavers observed 33.8% left gonadal arteries crossing left renal vein and grouped it into 3 types.

Embryological explanation of these types were forwarded by them and possible role of these types in compressive factors of left renal vein

resulting in varicocele, orthostatic albuminuria, pelvic congestion were also discussed.

F.R.C. JOHNSTONE, (1957)[53] summarized based on his observation on latex injected dissection of 10 specimens Single left suprarenal vein and inferior Phrenic vein joined the left renal vein at 3.1cm from IVC, opposite / medial to entry of left gonadal vein.

HOLLINSHEAD, (1957)[48] referred, studies of previous authors and compiled their findings. with addition of his own experimental description of collateral circulation in dogs.

RUSSELL T. WOODBURNE, A.M. Ph.D., (1957)[88] described left renal vein formed from tributaries issuing from both anterior and posterior sides of sinus of kidney.

RICHARD A. DAVIS, M.D., FRANK J. MILLOY, JR., M.D., BARRY J. ANSON, Ph.D., (1958)[84] made a series of dissection on lumbar veins between 1947 - 55 in 100 adult cadavers observed:

30 instances of 2nd left lumbar vein draining into left renal vein

3 persistent left post renal IVC

6 circumaortic leflt venous rings

2 retroaortie left renal veins.

RAYMOND H. REIS and GLENN ESENTHER, (1959)[79] studied 500 cadavers and obtained

Left renal venous collar 6%

Retroaortic left renal vein 2.4%

BARRY J. ANSON, Ph.D., and EDWARD H. DASELER, M.D., (1961)[7] studied common variations in renal blood supply from 235 bodies and illustrated few of the variations.

R.J. LAST, (1990)[64] described left renal vein formed by confluence of 5 - 6 renal segmental vessels with LRV - 7.5cm .RRV-2.5 cm and left renal vein as 3 times longer than right, receiving left suprarenal and left gonadal vein and possibly left inferior phrenic vein.

Ligation of left renal vein could be done to the right of entry of left gonadal and suprarenal veins. Rarely left renal vein might be double forming a circumaortic ring.

WILLIAMS, et ah, (1995)[101] in Gray's anatomy gave a higher value of 7.5cm as the length of left renal vein and said left > right bv 3 times.

Described left renal vein as :* opening into IVC at right angles, was anterior to left renal artery* Left gonadal vein entered it from below *left suprarenal usually with one of the left inferior phrenic entered from above, but nearer the midline.

RENAN UFLACKER, M.D., (1997)[83]gave from 52 cast preparations the, incidence of retropelvic tributary / vein on the left side

Retropelvic vein - draining in to IVC / left renal vein – 69%

Among it Retropelvic vein had a close relationship to upper infundibulum(or) junction of pelvis with upper calyx – 48%

Retropelvic vein related to middle posterior surface of renal pelvis – 21%

No retropelvic vein – 30%

Number of Venous tributaries forming left renal vein

Union of 2 tributaries - 53.8%

Union of 3 tributaries - 28.8%

Union of 4 tributaries - 15.4%

Union of 5 tributaries - 1.9%

SENECAIL B. et al., (2003)[93] reported one case of circumaortic and one case of retroaortic bifid left renal vein from dissected specimens with their clinical significance.

K.S.SATYAPAL, (2003)[91] did extensive study on renal veins for 7 years and investigated several pervious authors and reviewed their incidence. He classified the pattern of drainage of left renal vein.

VISHAL, VINAY et al (2014)[89] described retroaortic left renal vein with double left renal arteries.

RADIOLOGICAL AND CLINICAL REVIEW OF LITERATURE

CRAWFORD and DEBAKEY (1956)[20] excised venacava at the level of renal veins in a patient with a retroperitoneal leiomyosarcoma.

W.HENRY HOLLINSHEAD, Ph.D, JOHN A. MC FAR LAN E, M.D., (1957)[48] did experimental renal vein occlusion in dogs and studied the drainage fromn kidney through the development of collateral venous channels which laid the base for left renal vein ligation procedure.

CLARK (1961)[17] did a planned left renal vein ligation when operating on a malignant tumour.

HERBERT L. ABRAMS, M.D., et al., (1964)[45] Performed Cine renal venography on 40 patients with hypertension and found * Single left renal vein in 38 patients * 2 veins joining outside the kidney visible in 1 patient * Filling of left lumbar gonadal communications in 20 patients * capsular and suprarenal veins filled out in 5 patients

JERE W. LORD, JR., M.D., et al., (1964)[52] reported a case of Aorto left renal vein fistula where the vein was retroaortic in position.

D.EMERICK SZILAGYI, M.D., et al., (1964 - 68)[28] did 20 left renal vein ligation (3.6%) of 551 aortie surgeries at a selected point midway between the point of emptying of suprarenal vein and termination of left renal vein with IVC. This provided sufficient stump length to make reanastomosis later.

ERLIK, et al., (1965)[29,30] performed cadaver injection studies and found out that division of left renal vein not farther than 5 - 6 cm from its junctions with IVC would protect important tributaries, thus enabling continued left renal vein outflow. Using this as guide they did 5 portocaval shunt procedures with good post operative results

HORAN, (l967)[50], , GRAHAM, (1971)[39],L.L.MOHR et al., (1975)[73], also reported similar cases which caused technical difficulties during surgery.

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DUNCAN A. KILLEN, M.D., (1968)[25] compared the technique ot catheterization of renal veins in renovascular hypertension between percutaneous transfemoral and percutaneous transjugular approaches accepted that the former technique was easy and little risk prone.

HARRIS, et al., (1968)[43] studied the functional effects of left renal vein occlusion in dogs.

DOMINIC A. DELAURENTIS M.D., et al., (1970)[23] performed left renal vein ligation in 4 patients out of 41 patients they took in for abdominal aortic surgery, to the right of left suprarenal junction. With the venograms taken preoperatively they were able to demonstrate left 2nd lumbar vein joining left spermatic vein forming a common trunk as it entered left renal vein in 1 patient.

KOTTRA J.J, et al., (1970)[59] described angiographic appearance of circumaortic left renal vein as, * prearotic component crossing aorta at expected level * retroarotic component descending caudally 1 or 2 vertebral levels to enter IVC.

BOSNIAK. M.A, et al., (1972)[12], LIEN H.H., et al., (1977)[66] also described the same.

THOMAS T.V., (1970)[98] recommended proximal aortic occlusion with a vertical clamp, to avoid circumferential aortic dissection that might cause possible injury to a retroaortic left renal vein.

BRENER, et al., (1974)[11] reported * 2 cases of circumaortic left renal collar * 20 cases of retroaortic left renal vein from a series of 31 major venous anomalies of left renal vein and IVC. They also reported severe haemorrhage in 10/22 patients with retroaortic left renal vein. Of them 2 required nephrectomy for control of bleeding.

HAROLD A MITTY, M.D., (1975)[72] gave an radiographic account of 3 cases of circumaortic left renal collar and concluded that failure in recognizing dorsal component during retroperitoneal surgery might lead to haemorrhage, nephrectomy

THOMFORD N.R.,(1975)[99] classified the course of retroaortic left renal vein.

Type I

Coursing at the level of normal renal vein

Type II

Coursing obliquely caudal as low as iliac confluence

STUART A. ROYAL, PETER W. CALLEN.,et al (1979)[96] examined and described 4 patients having anomalies related to IVC by CT scan. They gave With rcference to previous authors the incidence of * Circumaortic Iefl renal vein: 1.5 - 8 7% * Retroaortic left renal vein: 1.8 - 2.4%

BABAIAN RJ, et al., (1979)[5] stated circumaortic and retroaortic left renal veins were important among the 4 most common major venous anomalies complicating retroperitoneal surgery.

CARL F. BECKMANN, HERBERT L. ABRAMS (1979)[16] out of 74 left renal venograms with 10cm bent tip radiopaque renal vein catheters bent at 130 to enter left renal vein, length of bent tip on left being 10cm and found incidence of cricumaortie left renal vein as 11%.

Following were the findings got from their study: * Diameter of preaortic limb: 11 - 22mm and it was longer than retroaortic, which entered IVC at L1- L2 with suprarenal entering preaortic limb. * in 2

cases gonadal entered preaortic limb. * in 4 cases gonadal entered undivided main left renal trunk. * in 6/ 8 cases retroaortic arose from undivided lett renal trunk within 2cm of hilum. In 2 / 8 cases it arose within hilum or at confluence of lobar veins.

POSITANO N. et al., (1980)[77] by selective renal venography in a patient with benign hematuria, found out circumaortic left renal vein as the cause.

KRAMER B. (1980)[60] investigated South African blacks for circumaortic venous collar encountered incidence of 5.9% - Males, 5. 1% - Females.

BUSCHI AJ, et al., (1980)[14]examined 72 patients by CT and sonography found marked variation in caliber between part distal to aorta and part directly in front of aorta and believed it to be secondary to 'nutcracker" effect formed by aorta posteriorly and superior mesenteric artery anteriorly.

PARIKH S.J, et al., (1981)[74] Analysed CT scan for anomalies of left renal vein and discussed the implications of various anomalies.

KUMAR. D, KUMAR. S., (1981)[62] were the first to document a case of circumaortic left renal vein by modality of CT scan.

REED, M.D., et al., (1982)[82] analysed 433 CT scans and gave incidence of *circumaortic left renal vein 4.4%* single retroaortic left renal vein - 1.8%.

REGINALD S.A. LORD, M.D., (1982)[81] advised trial clamping before division of left renal vein from his experience.

HERBERT L. ABRAMS, (1983)[1] from his study of 76 left renal venograms observed.

H.TOLLY E, et al., (1984)[42] Visualized 7 cases (0.95%) lett ovarian vein ectasia from 737 sonograms and CTscans of women aged 18 - 60 years, that were due to compression syndrome of left renal vein.

HALL JT, RAVAL B. (1986)[41] described a case of retroaortic left renal vein by CT scan.

DOUGLAS BALDRIDGE, M.D., et al., (1987)[24] summarised venous anomalies encountered in aortoiliac surgery as transposition / double / left IVC,preaortic iliac confluence, circumaortic and retroaortic left renal veins and reported incidence of cirumaortie left renal vein: 1.5 - 8.7%, retroaortie left renal vein - 2%.

SMITH R.M., et al., (1987)[95] encountered in 53 year old case of renal cell carcinoma that invaded an aberrant retroaortic left renal vein with an overlying aneurysmal aorta.

PAUL D. DEARING, M.D., et al., (1990)[75] reported 29 cases of left renal vein division close to confluence with IVC to facilitate proximal abdominal aortic exposure for reconstruction procedures.

KEITH D. CALLIGARO MD., et al., (1990)[56] performed division of left renal vein approximately 1 cm from its junction with IVC in 71 cases out of 1095 abdominal aortic surgeries without any postoperative sequelac.

SAMPAIO and ARAGAO, (1990)[15] stated in Campell's urology that a large vein frequently apposed the anterior and less often posterior

aspect of ureteropelvic junction - an important fact to consider when pyeloplasty was being performed either by open / endoscopic technique.

GAY S.B, et al., (1991)[35] stated that anomalies of left renal vein-retroaortic, circumaortic, double / left side lVC may confuse the diagnosis in CT scan and pointed that the radiologist should be aware of the anomalies in order to avoid errors in interpretation.

MARTINEZ ALMAGRO A, et al., (1992)[69] reported 6 cases of retroaortic left renal vein from 2/116 corpses and 4/170 CT scans done on patients with non pathological retroperitoneum; the left renal vein obliquely coursing retroaortically towards IVC.

LEE C.M, et al., (1992)[65] reported first case of circumaortic left renal vein from Taiwan in a 15 year old girl by angiogram and CT scan.

HICKS M.E, et al., (1995)[46] in their comparative study of sensitivity of selective venography with that of cavography in the detection of anatomical variants of renal vein that may affect placement of IVC filters in 108 patients and found 11% variants by cavography and 37% by selective renal vein injection. Anamolies included 11 cirumaortic

left renal vein, 25 multiple renal veins, 2 retroaortic left renal vein and 1 partial duplication of IVC.

JACK BANIEL, en ah, (1995)[51] did 102 retroperitoneal Iymphnode dissections during clinical staging of carcinoma testis and observed significant variation in the number and topography of lumbar veins. Of 72 patients 31 (43%) had lumbar vein / veins entering left renal vein. This lumbar vein was usually posterior to entrance of left gonadal vein. In 9 (29%) 2 lumbar veins joined together and entered left renal vein in a common trunk. 5 (5%) had 2 lumbar veins entering left renal vein separately. 3(3%) retroaortic left renal vein with a large lumbar vein connecting posteriorly to left of aorta. They also described the techniques to maintain control of bleeding upon accidental Injury to these lumbar vessels during retroperitoneal surgery.

RODITI G.H, et al., (1996)[85] examined and evaluated 71 patients with comprehensive 2D time of flight abdominal magnetic resonance venography in 3 planes for left renal venous anomalies found out, 6 cases of circumaortic-8.5% with the retroaortic limb passing in a caudal direction to join IVC inferior to preaortic limb and 1 case of retroaortic.

KIM S.H, et al., (1996)[58] investigated cases of sudden onset gross hematuria in otherwise healthy patients with Dopplcr ultrasonography and found out that the compression of left renal vein between aorta and superior mesenteric artery "Nut cracker phenomenon ' as the cause.

SAKAMOTO N. et al., (1997)[90] presented 35 years old woman of Budd Chiari syndrome to have complex venous anaomalies that included a retroaortie left renal vein.

GIBO M, et al., (1998)[38] described a case of retroaortic left renal vein with hematuria due to "Nut cracker phenomenon".

TRIGAUX J.P, et al., (1998)[34] evaluated the incidence and configuration of left renal vein variants and the entry of these veins into IVC from spiral CT scans of 1014 patients.

The results were:

102 left renal vein variants (10%).

38 Retroaortic (3.7%)

Distance between the entrance of left renal vein into IVC and confluence of iliac veins was 62.5mm + 8.7

64 Circumaortic (6.3 %)

Distance between the entrances of preaortic & retroaortic limbs into IVC was 39.0 mm + 17.4 . Distance between the entrance of retroaortic limb into IVC and confluence of iliac veins was 63.2mm + 17.

This knowledge being crucial for IVC filter placement, spermatic vein embolization, adrenal / renal venous sampling.

COLL D.M, et al., (1999)[18] from preoperative 3D volume rendered CT evaluation of 69 patients who underwent nephron sparing surgery reported cases of circumaortic left renal vein 4.3%.

EDWARD BASS J., et al., (2000)[26] described a spectrum of congenital anomalies of IVC with the help of cross sectional image findings in which he had explained in detail the presentation of circumaortic and retroaortic lett renal veins with its embryological basis

and concluded that awarness of these anomalies is necessary to avoid diagnostic pitfalls.

SHINDO S. et al., (2000)[94] encountered 4 patients with major venous anomaly out of 166 patients who underwent abdominal aortic surgery over 6 year period. Of the 4, 1 turned out to be circumaortic renal collar which was missed out in preoperative imaging. They committed that evcn though it was rare to encounter major venous anomaly in aortic surgeries, awareness being important, as a patient with an anomaly of left renal vein and an inflammatory abdominal aortic aneurysm belongs to high risk group.

KARKOS CD., et al., (2001)[55] stated 6 anatomical variants of IVC and left renal vein as:

1.Retroaortie left renal vein - type I and II.

2.Circumaortic left renal vein.

3.Duplication of IVC.

4.Transposition of IVC.

5.Left sided IVC.

6.Preaortic iliac confluence

KAPIL SEWSARAN SATYAPAL, et al., (2001)[54] from a retrospective review of circumaortic left renal collar from invivo and cadaveric studies gave incidence as 0.6%.

TODO R. et al., (2001)[100] encountered during his surgery on 72 years old man of abdominal aortic aneurysm, a massive haemorrhage, due to accidental injury of rctroaortic component of a circumaortic lefl renal vein which was missed out in preoperative CT scan.

KIANG - HIONG TAY, et al., (2002)[57] reviewed their experience in performing venography of left spermatic vein and varicocele embolization in 18 men with circumaortic left renal vein and concluded that the site of confluence of lefl spermatic vein with left renal vein was variable from patient to patient and it necessitated the use of transjugular and transfemoral venous approaches to do the procedure.

DIGITAL OBJECT IDENTIFIER (2002)[22] described left renal vein as : * 3 times longer than right renal vein * 3% retroarotie * 8 - 17% circumaortic * 75% extrahilar bifurcation of single left renal vein * less

common was 2 separate renal veins originating at hilum * 15% normally contained valves * Joined IVC at angle of 90.

RAHALKAR MD, (2002)[78] in his oration on the embryogenesis of IVC anomalies and the difficulty in their interpretation by CT; gave an incidence of * 2 - 3% retroaortic left renal vein * 6 - 8.7% circumaortic left renal veins.

AGUILAR RIVILLA E, et al., (2002)[3] analyscd incidence of left circumaortic renal veins in 50 gonadal embolization procedures for symptomatic varicocele and found 2 cases (4%) circumaortic left renal vein. Also found that the gonadal ostium to be in the preaortic confluence of venous ring in one case and was not able to localize in another case and concluded that the presence of cirucmaortic left renal vein was a technical difficulty in performing embolization of symptomatic varicocele.

KUDO F.A, et al., (2003)[61] reported a case of 77 year with abdominal aortic aneurysm diagnosed pre operatively by contrast CT to have retroaortic left renal vein which enabled successful surgery without venous complications.

YUKI YAO, et al., (2003)[102] examined 100 patients for incidence and appearance of the communicating vein between the left renal vein and left ascending lumbar vein on abdominal CT, they recorded * 35% - visible communicating vein * the distance between the superior mesentcric artery and aorta was narrower 11.6 + 5.2 mm in patients with visible communicating veins * in those without it the distance was 13.5 + 4.1 mm. They concluded that this vein is visible in general population and care should be taken not to confuse it with lymphadenopathy as this communicating vein was partially visualized within the paraortic region in 20% of the cases.

D' ARCHAMBEAU O. et al., (2004)[21] studied pelvic congestion syndrome in 67 women over a period of 8 years and found out that 83% pelvic congestion resulted as a sequelae of extrinsic compression of left renal vein between aorta and superior mesenteric artery - "Nut cracker phenomenon leading to left ovarian vein congesion and pelvic varicosities.

TANAKA H,WAGAS, (2004)[97] reported a case of 14 year boy with gross hematuria, mild proteinuria due to 'Nut cracker phenomenon by main renal artery.

GRAVEREAIUX E.C, et al., (2004)[40] stated that predominantly central venous anomalies like retroaortic, circumaortic, absent / left sided / duplicated IVC were clinically silent and they gained relevance only when aortic (or) IVC procedures were planned.

LENNARD A. NADOLO MD et al (2004)[67] while explaining on the surgical complications of kidney transplant had emphasized selection of left kidney in most cases of laproscopic donor nephrectomies and added that most common venous anomalies complicating the procedure included thc retroaortic left renal vein, early branching of renal veins, anomalies of the anastomosis between the renal veins and lumbar and gonadal veins.

F.M ANDREA, R.P ROCHA et al (2005)[32] describes a rare variation of retroaortic left renal vein with anastomotic affluent from inferior mesenteric vein causes misleadind in radiological imaging.

BALCI, SADIK GORUR, HOLDEN SUMBAS et al (2007)[9] studied the incidence of retroaortic left renal vein in patients with varicocele based on ultrasonogram study in 140 patients. He observed 13 pt (9.3%) is with retroaortic left renal vein.

KALRA, REED NR, VRITSKA, GLOVICZKI (2008)[63] et al describes nut cracker syndrome caused by compression of left renal vein between superior mesenteric artery and aorta causing left renal and gonadal hypertension and left renal vein transposition is the treatment of choice.

ILKAN ATAR, HUSEYIN GURKAN TORE et al (2008)[80] reported retroaortic and circumaortic left renal veins with their CT findings and explained the prevalence as 0.5 to 6.8% an 0.3 to 3.7% respectively.

HENRY KNIPE & DR. YURANGA NEERODY (2009)[10] et al describes variation in left renal vein as 4 types.

Type I – ventral pre aortic limb is obliterated, and dorsal limb persists and join with inferior vena cava.

Type II – ventral limb obliterates, and dorsal limb turns in to retroaortic left renal vein and left renal vein lies at level of L4-L5.

Type III – venous collar due to persistent subsuprcardinal and intersupracardinal anastamosis and dorsal limb of left renal vein.

Type IV – ventrl limb obliterates an dorsal limb persists as retroaortic left renal vein.

SAMSON CH, LOAPORE MR JR (2009)[19] et al explains the long term safety of left renal vein division and ligation based on the study of 56 pts, showed renal compromise and haematuria was not encounteredSUNG WOO PARK, JOHNG KIL NAM (2010) et al explains the clinical features of retroaortic left renal vein s haematuria , inguinal pain and ureteropelvic junction obstruction with retrospective study of 12 patients and explained Type I RLRV is common.

GENERAL ANATOMY

The left renal vein emerges from the left renal hilum, in front of left renal artery.

It runs posterior to the splenic vein and the body of pancreas,then crosses the anterior aspect of the aorta, just below the origin of the superior mesenteric artery to drain in to inferior vena cava.

The left gonadal (testicular/ovarian) vein enters it from below.

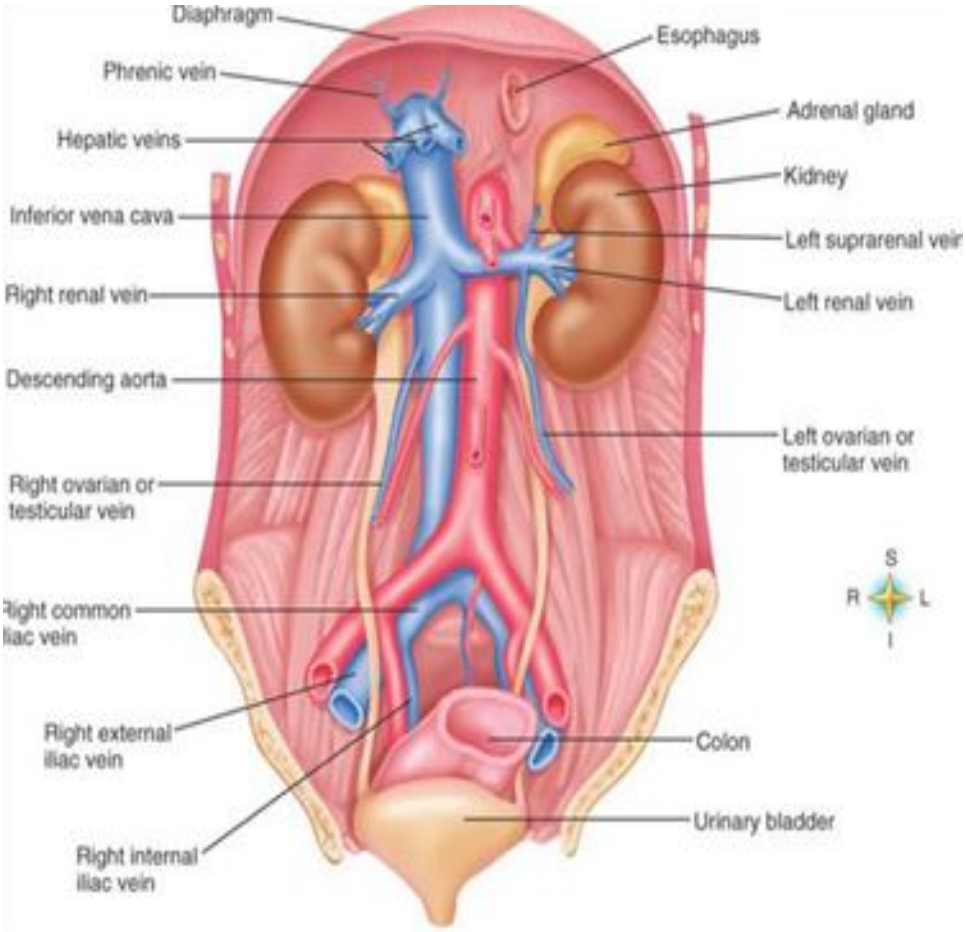
The left suprarenal vein, usually receiving one of the left inferior phrenic veins, enters it above but nearer the midline.

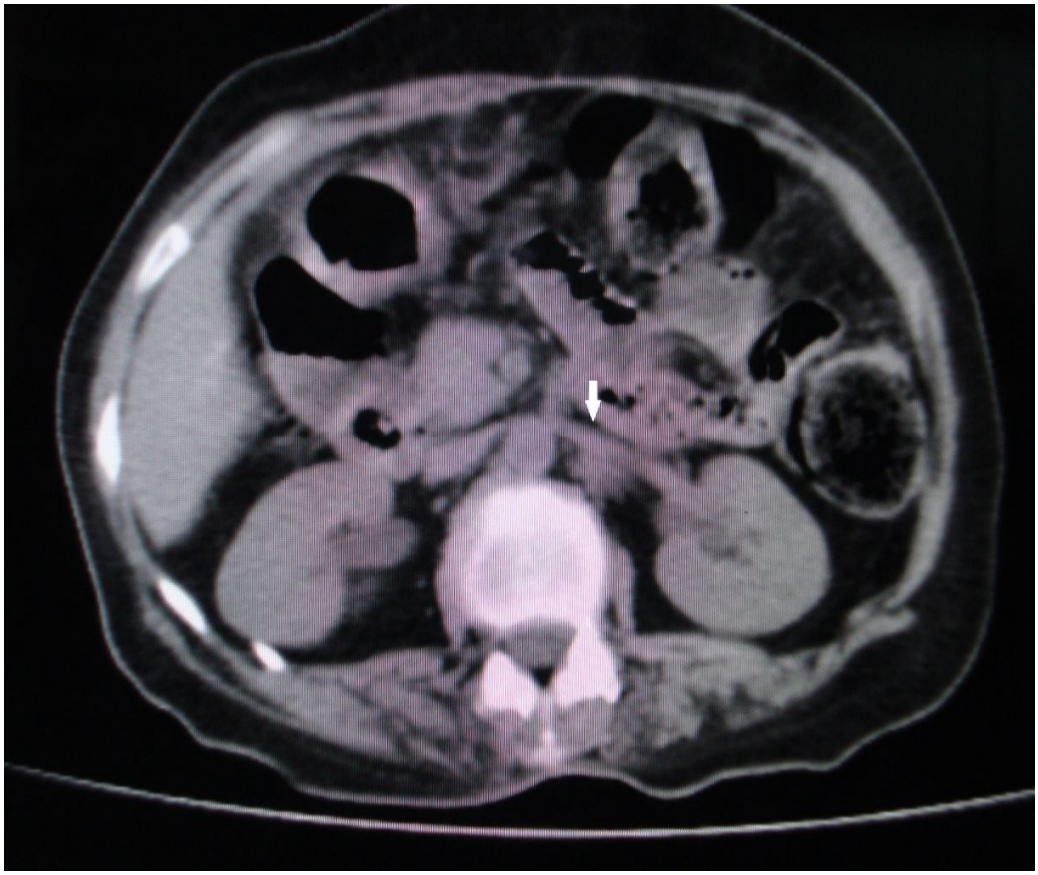
The left renal vein is three times longer than the right (7.5 cm and 2.5 cm respectively.

Compared to the left the right renal vein takes a short course and joins the inferior vena cava.

The right suprarenal and right gonadal vein opens diretctiy in to inferior vena cava.

GROSS ANATOMY PICTURE SHOWING LEFT RENAL VEIN, ITS RELATIONS AND ITS TRIBUTARIES

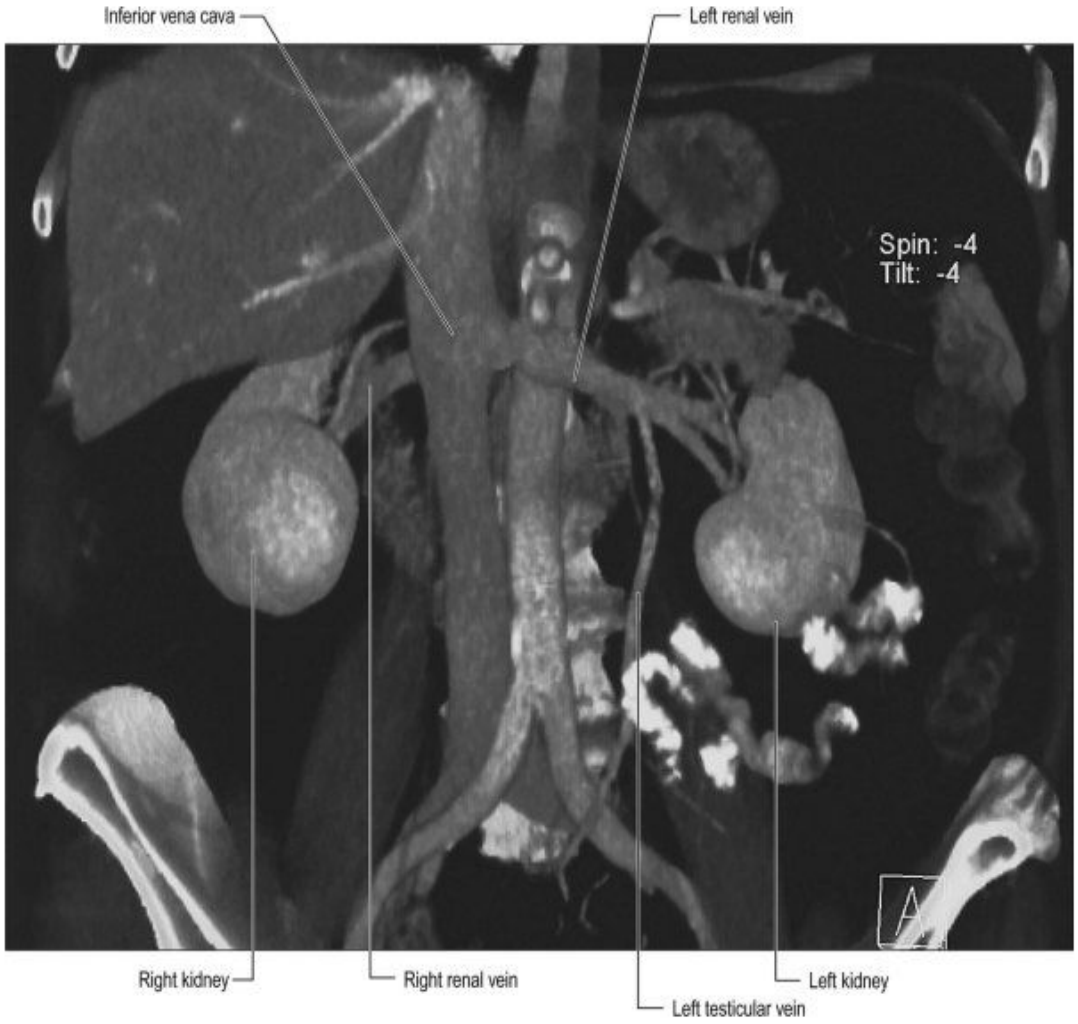




MULTIDETECTOR COMPUTED TOMOGRAPHY (MDCT) AXIAL SECTION

OF ABDOMEN AT THE LEVEL OF KIDNEYS SHOWING LEFT RENAL VEIN

(WHITE ARROW)



CORONAL RECONSTRUCTED MDCT PICTURE SHOWING LEFT RENAL

VEIN WITH ALL ITS TRIBUTARIES.

EMBRYOGENESIS

Between 6-8 weeks of intrauterine period, by a complex process involving development, anastomosis and regression of 3 pairs of embryonic venous channels lying in proximity to developing mesonephros, the left renal vein and its tributaries are formed.

In order of appearance,

Left and right posterior cardinal veins appear on dorsal side of mesonephri followed by

Left and right subcardinal veins on medial and ventral aspect of mesonephri.

The left and right supracardinal veins appear dorsal and medial to posterior cardinal veins.(Huntingdon and Mcclure)[70] , (Frazer)[13]

The subcardinal veins communicate cranially and caudally with posterior cardinal veins, while themselves receiving veins from the developing kidneys.

At the level of renal veins, the 2 subcardinal veins become connected by a transverse inter subcardinal anastomosis (10mm length-37 day embryo)

The supracardinal veins communicate cranially and caudally with posterior cardinal veins and also communicate with subcardinl veins through anastomosis just below renal veins.

The left renal vein is derived from:

A) mesonephric vein that originally drains in to left subcarinal vein,

B) a part of left subcardinal vein,

C) the inter-subcardinal anastomosis.

As this anastomosis lies in front of aorta, the left renal vein has a similar relationship.

The left suprarenal vein is formed by part of left subcardinal vein above the inter-subcardinal anastomosis.

The left gonadal vein is formed from part of left sub-cardinal vein below the inter sub-cardinal anastomosis.

Embryology of variations

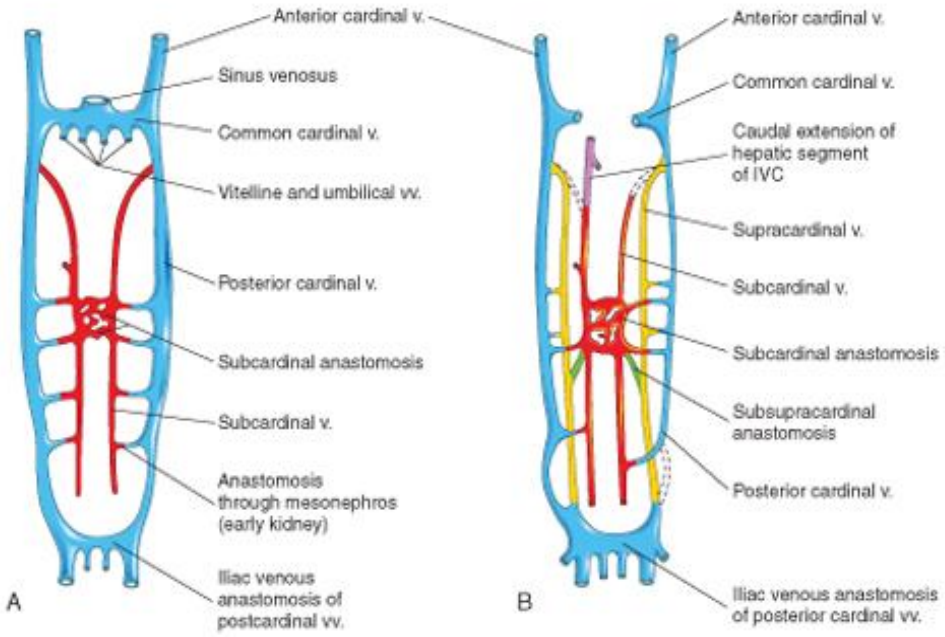
Supracardinal vein also have numerous anastomosis behind aorta. A post aortic cross channel in the region of left renal vein and anastomosis between the supracardinal, posterior cardinal, subcardinal veins at same level if its persists will result in retroaortic renocaval arch (by Seib-1934)[92].

These together with inter subcardinal anastomosis ventral to aorta establishes circumaortic left venous ring (called by Huntingdon and Mcclure-1920 as renal collar)[70].

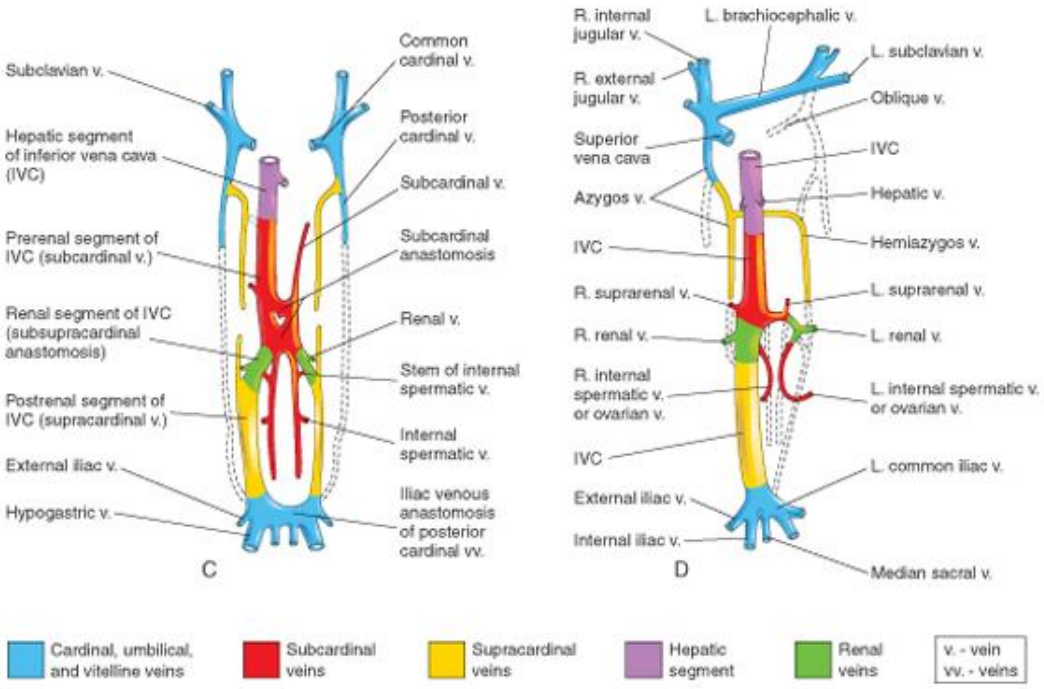
The relation between left gonadal artery and left renal pedicle can be explained on the basis of the gonads developing fro urogenital fold cranial to kidneys, the latter developing in caudal position. As they cross each other to their definitive position, the gonadal artery passes in front of kidney and its vascular elements.

When crossing over, two kinds of mesonephri arterial branches reach the gonads, one cranial and other caudal to the developing renal vascular pedicle. Depending on which artery persist as definitive gonadal artery, the varied type of relation between left gonadal artery and left renal pedicle result

EMBRYOGENESIS OF LEFT RENAL VEINS AND ITS COMMUNICATIONS



EMBRYOLOGY OF VENOUS CHANNELS, ALL CARDINAL VEINS FORMATION AND ITS ANASTOMOSIS



EMBRYOLOGY OF LEFT RENAL VEIN (GREEN COLOUR)

MATERIALS AND METHODS

Materials of study

- 22 embalmed and preserved adult human cadavers.
- 8 postmortem enbloc specimens.
- 20 patients in Radioloy Department who came for Computed tomography abdomen for varied indications

Method of study

Cadaveric study

Study was done on 22 embalmed and preserved human cadavers of both sexes that were put in for the teaching programme of undergradute & postgraduate medical students at the Department of Anatomy, and 8 postmortem enbloc specimens obtained from Department of Forensic medicine, Stanley medical college, chennai.

Radiological study

20 patients with varied abdominal symptomatology that came for contrast enhanced Computed tomography (CT) abomen for varied abdominal indications were taken up for this study at the Department of Radiology, Stanley medical college, chennai.

For the above patients only images was taken with data already available in the department with both contrast study of abdomen done in both arterial and venous phase and plain CT abdomen to delineate structres in a better way.

By conventional dissection method as per Cunnigham's dissection manual[86].

The anterior abdominal wall was incised and opening of abdominal cavity in the midline was done. Peritonael cavity and visceras were defined and studied.

Removal of stomch, liver, jejunum, ileum with their mesentry, transverse colon with mesocolon was done.

The posterior parietal peritoneum was defined and stripped off exposing the retroperitoneal structures(Inferior vena cava, abdominal aorta, sympathetic chains, suprarenal and kidneys with fascial coverings, psoas muscle with its fascia).

Meticulous dissection was done to delineate major vascular trunks. The superior mesentric arterial trunk was kept as a guide for defining left renal vein. The fat and fascia covering the left kidney and supararenal area were cleared.

Left renal hilum cleared to visualise and delineate hilar structures.

The pattern of extra hilar confluence of tributaries in forming left renal vein with respect to its number and relation to left renal arterial branches was studied.

Left suprarenal vein, left inferior phrenic vein were traced from above.

Their mode of drainage in to left renal vein was noticed. Left gonadal vein was also traced from below.

The pattern of termination of left gonadal vein in to left renal vein was traced out.

(Left gonadal artery that was accompanying its vein was also delineated and its relation to the left renal vein was studied. Left renal vein was displaced a little for left renal artery and the relation between them was made out.)

Left kidney was lifted from underlying psoas major and quadratus lumborum muscle, turned medially to expose the posterior part of renal pelvis.

Careful clearing of fat pad from retropelvic area was done to visualise the presence or absence of retropelvic veins or venous anastomosis.

Left psoas major muscle defined and its fascial coverings stripped off.

Taking 3^{rd} and 4^{th} lumbar transverse processes as guide, meticulous dissection was done to identify 2^{nd},3^{rd},and 4^{th} lumbar arteries and veins.

The lumbar veins were traced as it emerge from below the psoas and their termination either in to the left renal vein or inferior vena cava was studied.

The main left renal venous trunk was followed across the aortic terrain and whether its courses as preaortic (normal), retroaortic or circumaortic towards inferior vena cava was noted.

The angle formed by the main left renal vein as it terminates in to inferior vena cava was made out and vertebral level also noted.

By radiological method,

Images obtained from Multidetector Computed tomography (MDCT) from 20 patients,were reconstructed in to coronal and axial views.

The length of left renal vein, was measured by linear measuring tool.

Its angle forming with Inferior ven cava, was measured in coronal reconstruction image with angle measurement tool.

Its relation to left renal artery and incidence of left renal vein variants was observed in both views.

The following 10 parameters was taken for the present study (The first 6 parameters by dissection method, and the remaining 4 parameters by both dissection and radiological method)

1. Pattern of confluence of tributaries forming left renal vein.
2. Incidence of retropelvic venous tributary/vein.
3. Mode of termination of left suprarenal and inferior phrenic veins.
4. Mode of termination of left gonadal vein.
5. Relation of termination of left common trunk (left suprarenal and inferior phhrenic union) to left gonadal vein.
6. Distance of point of termination of left suprarenal/ common trunk from left margin of inferior vena cava.
7. Relation of left renal artery to left renal vein.
8. Incidence of left renal vein variants.
9. Length of left and right renal veins.
10. Angle formed between left renal vein and inferior vena cava.

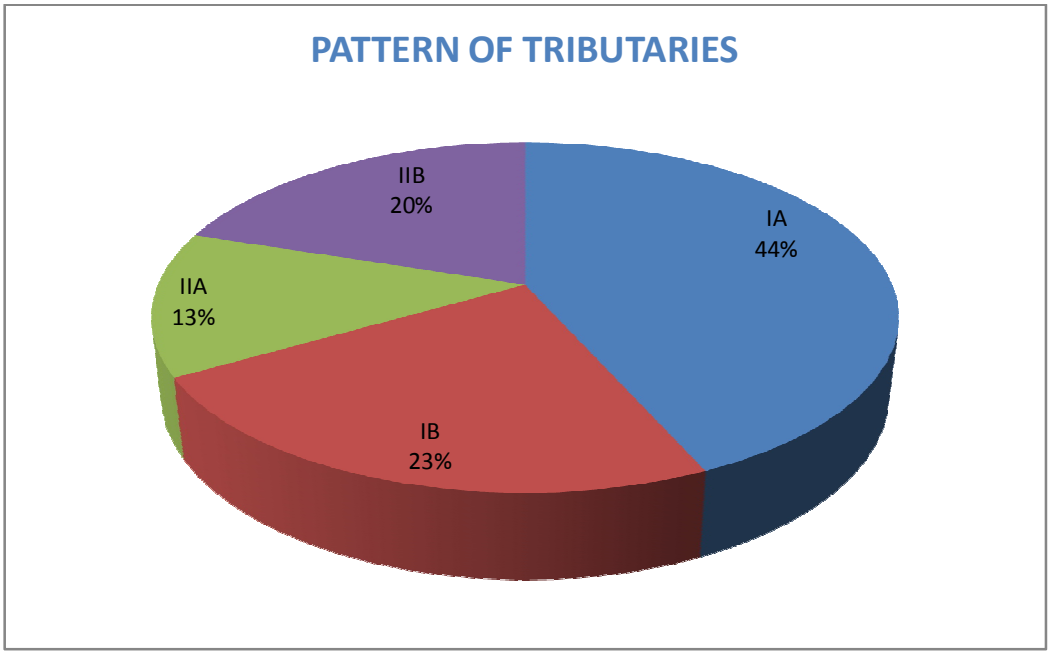
OBSERVATION

Observation made upon 22 human adult cadavers, and 8 enbloc specimens along with parameters studied by radiological method in 20 pts in total are analysed and summarised.

6 parameters which can be assessed only by dissection method and 4 parameters which was assessed by both radiological and dissection method were presented here.

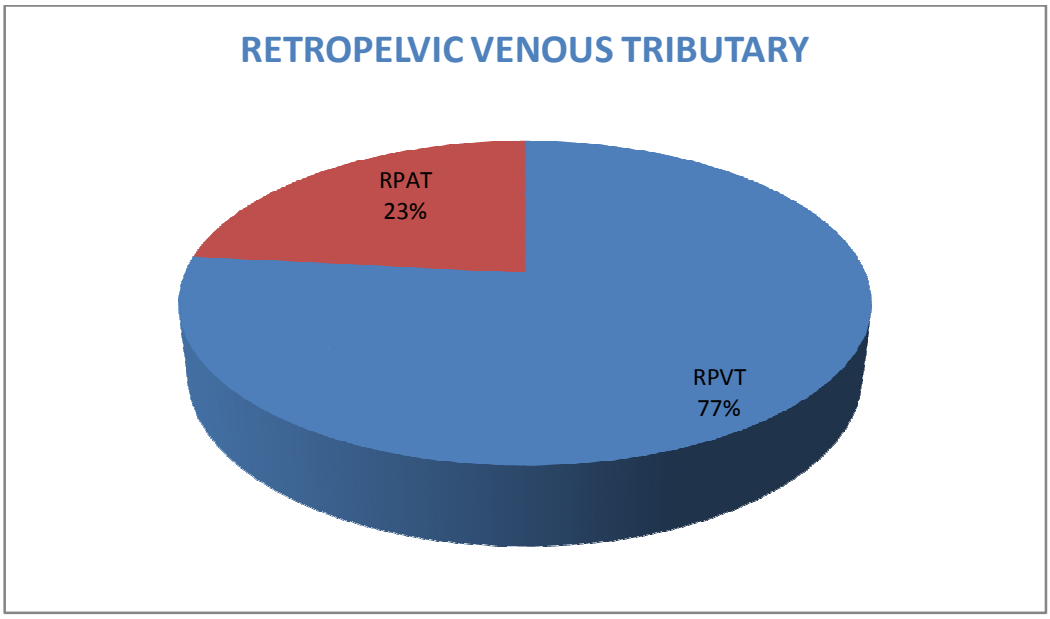
1.Pattern of confluence of tributaries forming left renal vein.(based on Satyapal's claassification)[91] in 30 specimens.

Type	Pattern	No	Percentage
I A	2 anterior	13	43.33
I B	2 anterior & 1 posterior	7	23.33
II A	3 anterior	4	13.33
II B	3 anterior & 1 posterior	6	20
III	Any above + With LRV	nil	



2.Incidence of Retropelvic venous tributary/vein forming left renal vein.

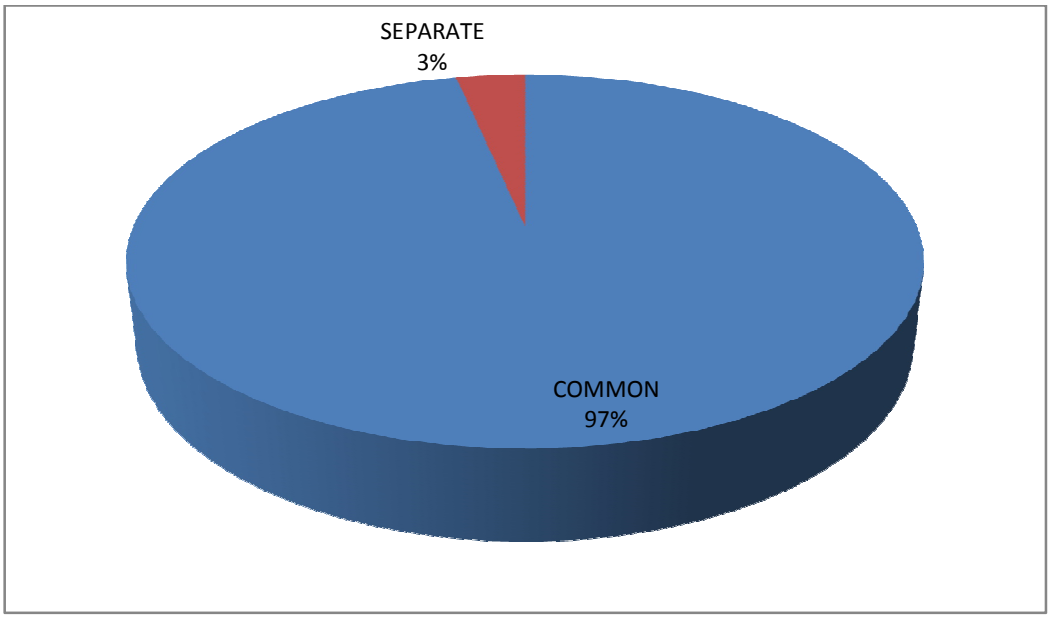
Total no specimens	30	Percentage
Retropelvicvenoustributary	23	76.66
Retropelvicarterial branch	07	23.33



3.Mode of termination of left suprarenal and inferior phrenic veins in to left renal vein.

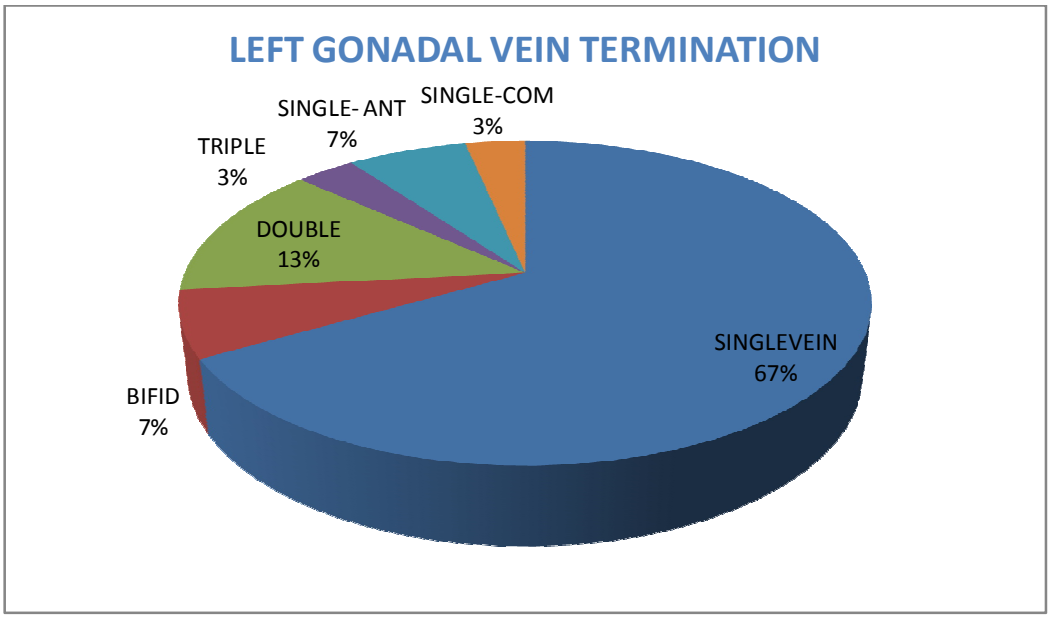
No. Of specimens studied	30
Common trunk formation	29

A single case - separate drainage of inferior phrenic vein was detected.



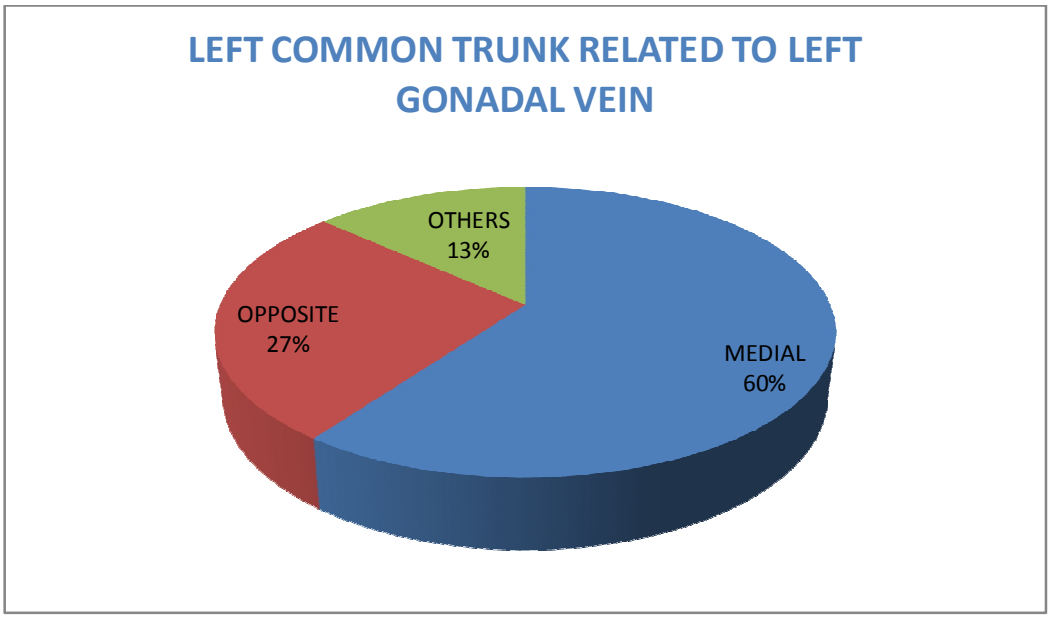
4.Mode of termination of left gonadal vein in to left renal vein

No.of specimen studied	30	%
Single vein, caudal border	20	66.66
Bifid vein, caudal border	02	6.66
Double veins, caudal border	04	13.33
Triple veins, caudal border	01	3.33
Single vein in anterior surface of Left renal vein	02	6.66
Single vein joining common Trunk in cranial border	01	3.33



5.Relation of termination of left common trunk(union of left suprarenal and left inferior phrenic) to the left gonadal vein in reference to left renal vein.

No.of specimens studied	30	Percentage
Left common trunk medial to left gonadal vein	18	60
Left common trunk opp to left gonadal vein	08	26.66
Others	04	13.33



6.Distance of point of termination of left suprarenal vein/common trunk from left margin of inferior vena cava

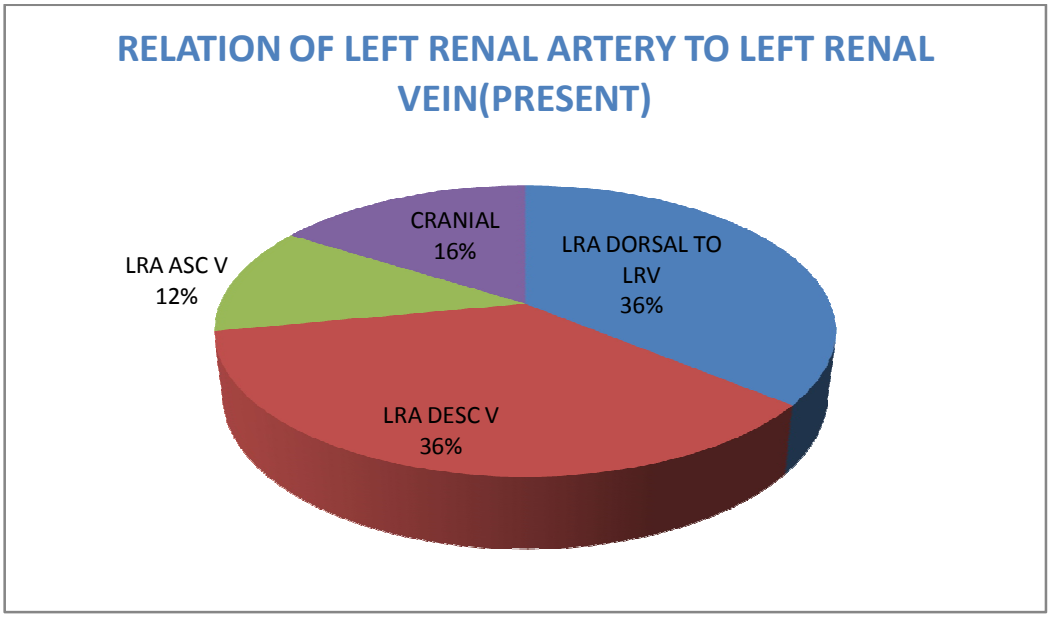
Computed from measurements got from 30 specimens table

Average distance – 2.51cm. (range: 1.2-3.8cms)

7. Relation of left renal artery to left renal vein(as per berry and daseler's classification)[6]

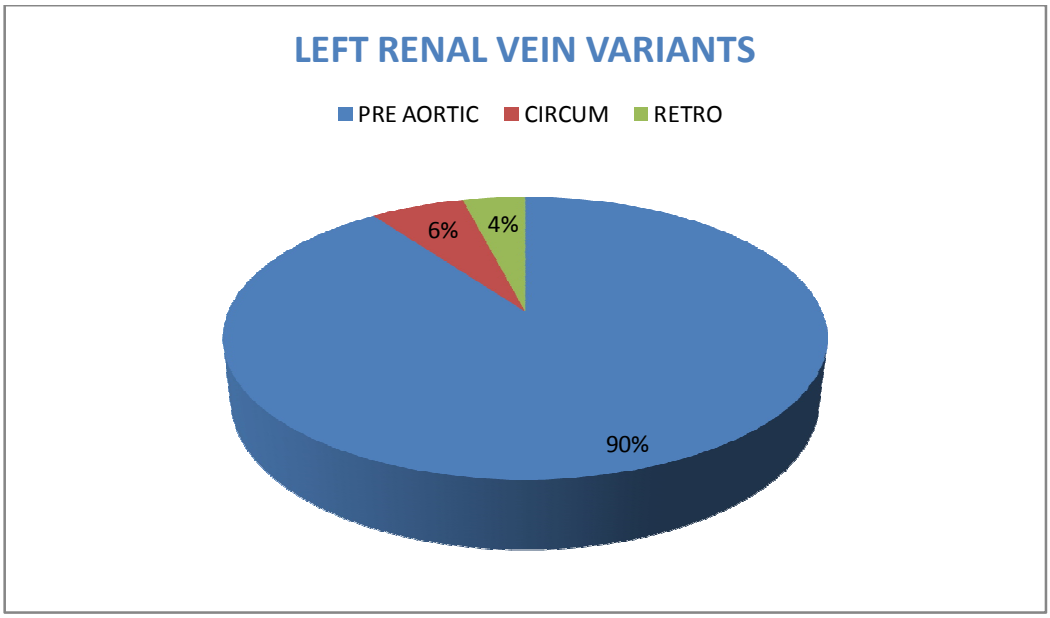
No. Of specimens studied - 50

Left renal artery dorsal to left renal vein	18	36%
Left renal artery descending to ventral position	18	36%
Left renal artery ascending to ventral position	06	12%
Left renal artery cranial to left renal vein	08	16%



8. Incidence of left renal vein variants

No. Of specimens	50	%
Retroaortic left renal vein	2	4
Circumaortic left renal vein	3	6

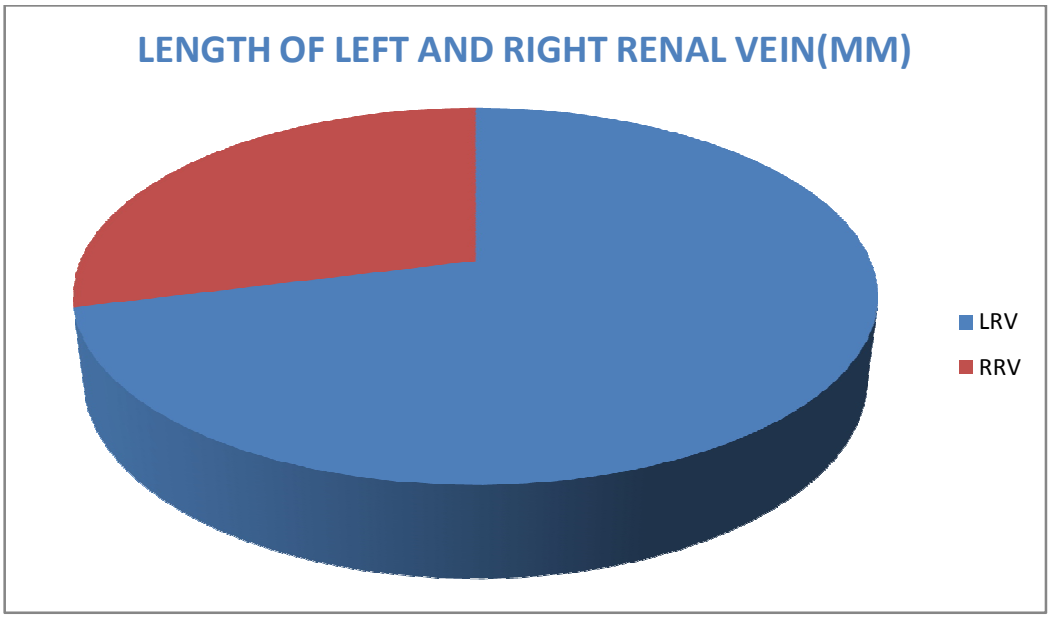


9. Length of right and left renal veins

Measurements got from 30 specimen and contrast CT abdominal readings of 20 patients were taken into consideration.

Average length of left renal vein - 5.9cms (2.4-9.4cms)

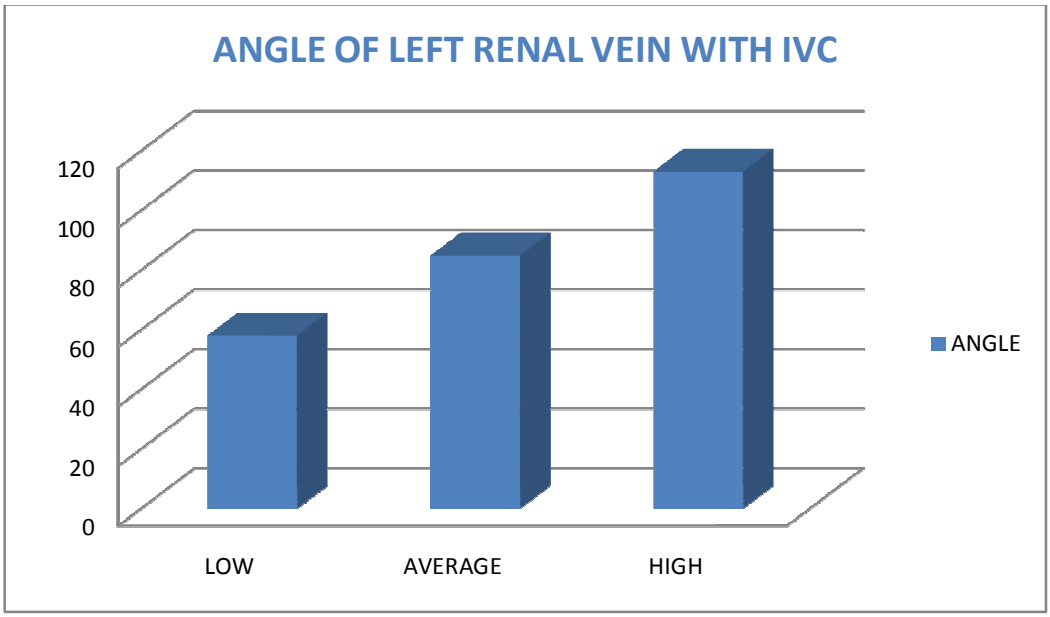
Average length of right renal vein - 2.4cms (0.9-4.5cms)

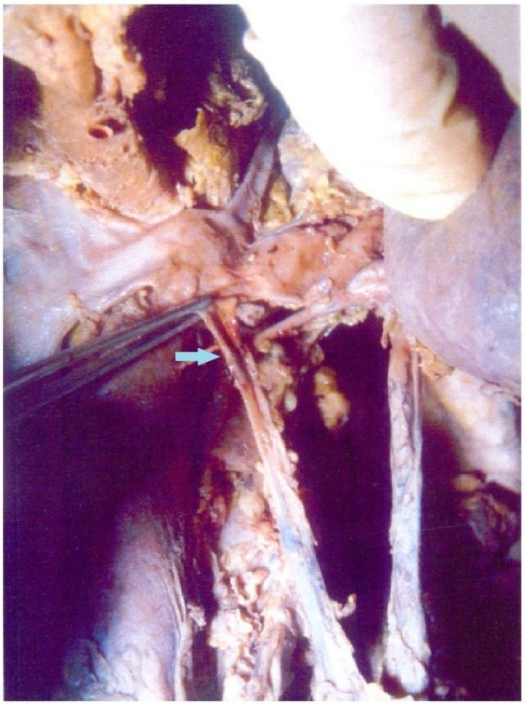


10. Angle formed between left renal vein and Inferior vena cava.

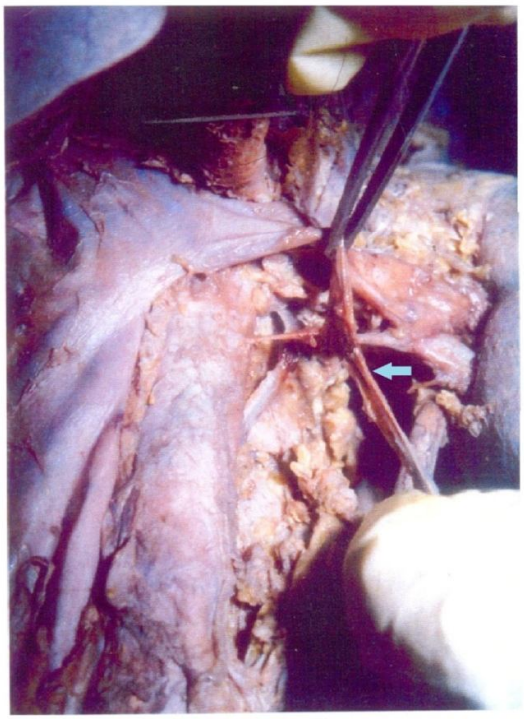
Average angle that formed between it that found in both study (50) were summated

Average angle – 84.8^{o} (range 58^{o} – 113^{o})





LEFT GONADAL ARTERY TRAVERSING THROUGH HIATUS IN CAUDAL BORDER OF LEFT RENAL VEIN

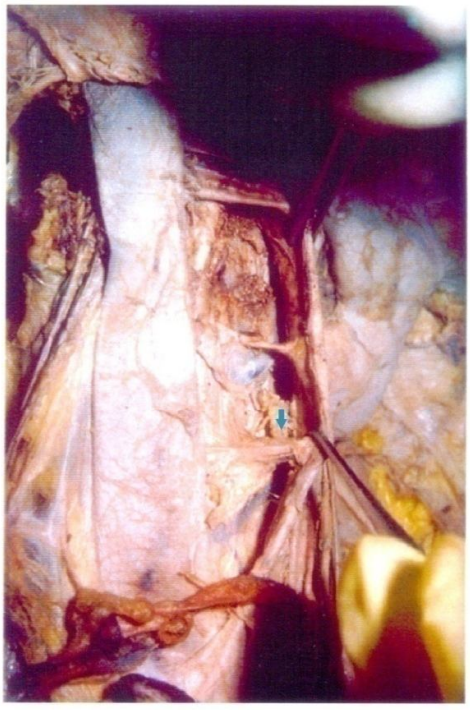


2ND LEFT LUMBAR VEIN JOINING DORSAL ASPECT OF LOWER SEGMENT OF LOOP

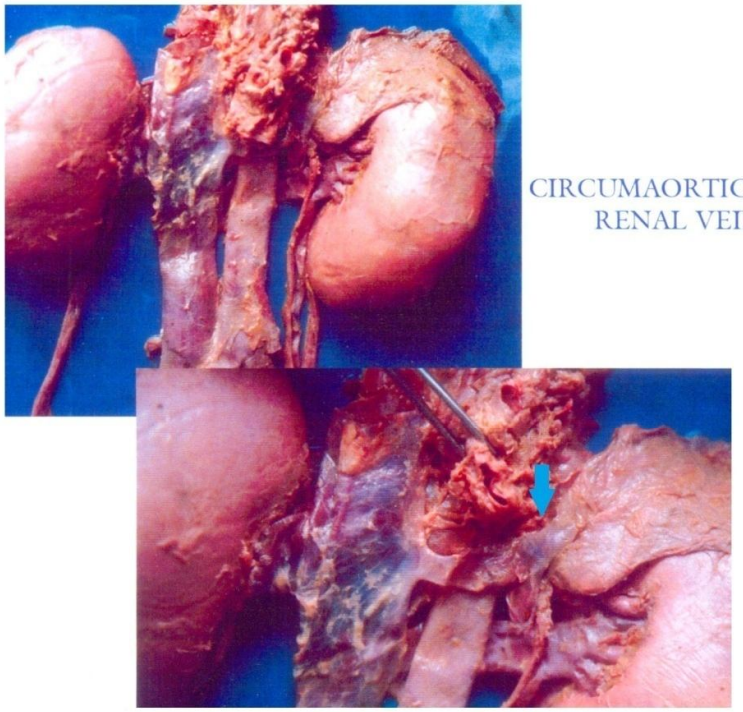
CIRCUMAORTIC
LEFT RENAL VEIN

CLOSER VIEW:LEFT
GONADAL ARTERY HOOKING OVER
THE CONNECTING CHANNEL

RETROAORTIC LIMB BIFID AT ITS
TERMINATION

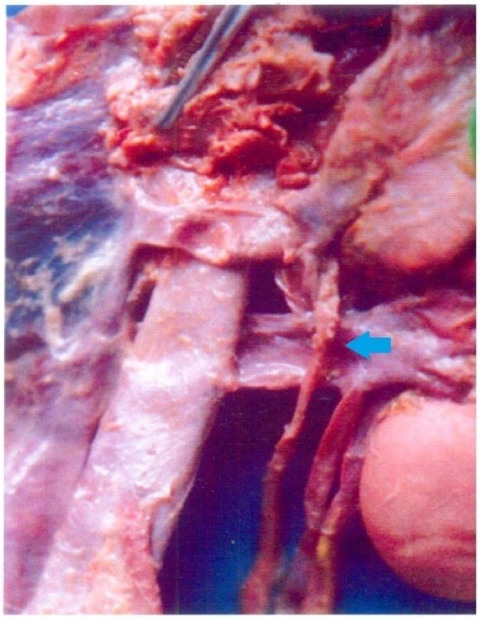


POSTERIOR VIEW:2ND LEFT LUMBAR
VEIN JOINING POSTERIOR ASPECT OF
RETROAORTIC SEGMENT



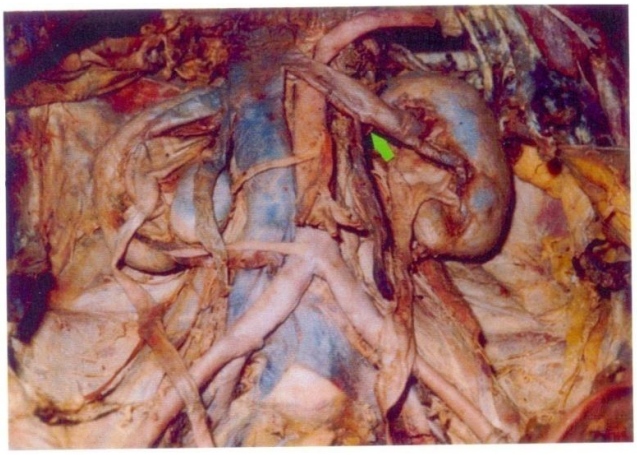
CIRCUMAORTIC LEFT RENAL VEIN

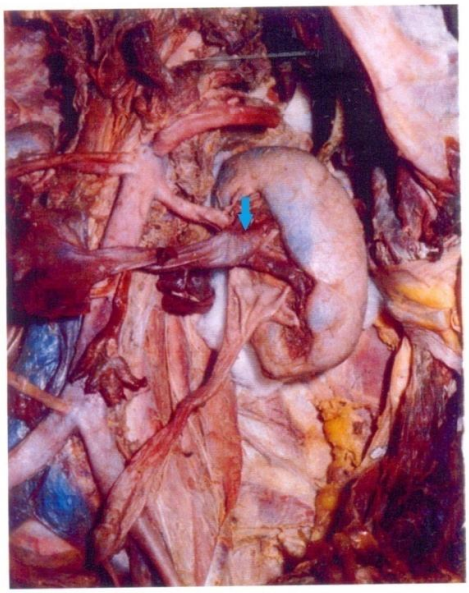
CLOSER VIEW : LEFT GONADAL ARTERY HOOKING OVER LEFT RENAL VEIN



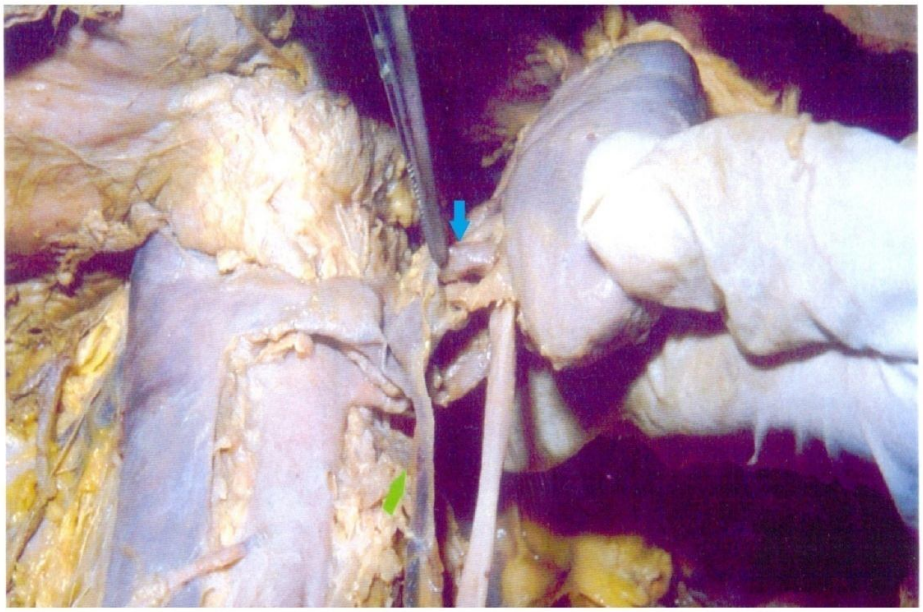
BILATERAL NON ROTATED KIDNEY,EXTRA RENAL PELVIS, RIGHT MULTIPLE RENAL ARTERIES AND DOUBLE RENAL VEIN

2nd LEFT LUMBAR VEIN TERMINATES IN POSTERIOR ASPECT OF LEFT RENAL VEIN

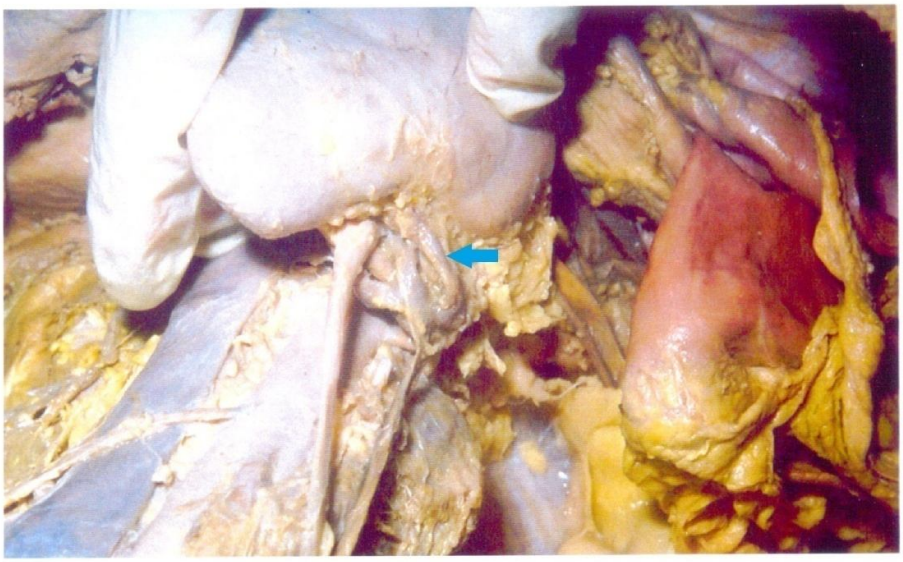




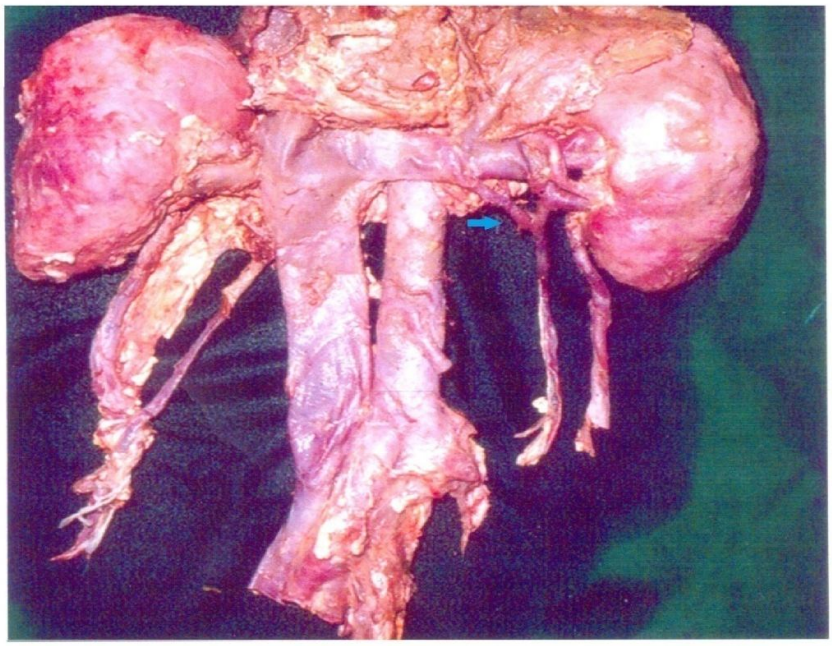
3 ANTRIOR TRIBUTERIES CONFLUENCE FORMING LEFT RENAL VEIN



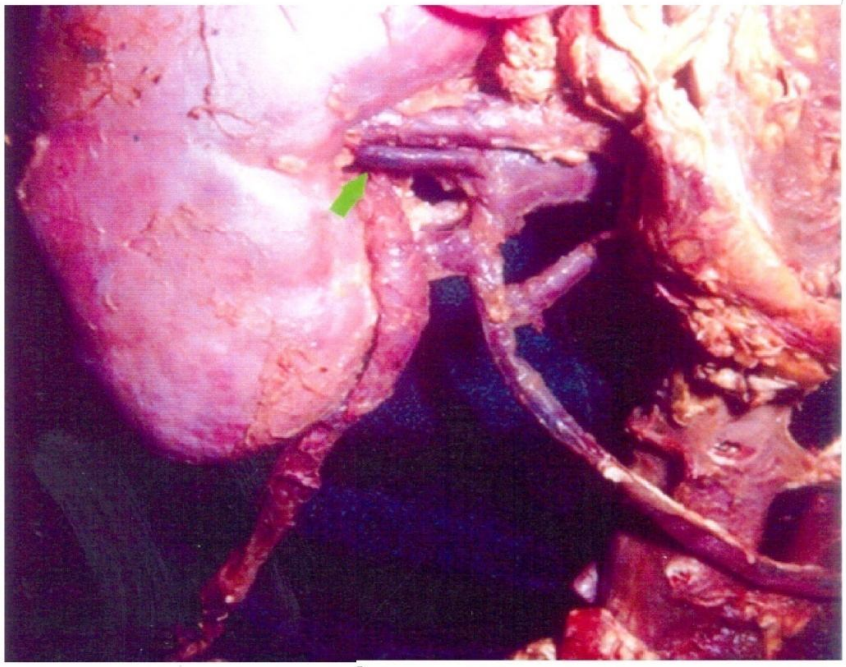
CLOSER VIEW:BRANCH OF LEFT RENAL ARTERY TRAVERSING LOWER ANTERIOR AND POSTERIOR TRIBUTARIES
2nd LEFT LUMBAR VEIN JOINING LEFT GONADAL VEIN IN POSTERIOR ASPECT



POSTERIOR VIEW:RETROPELVIC VENOUS TRIBUTARY

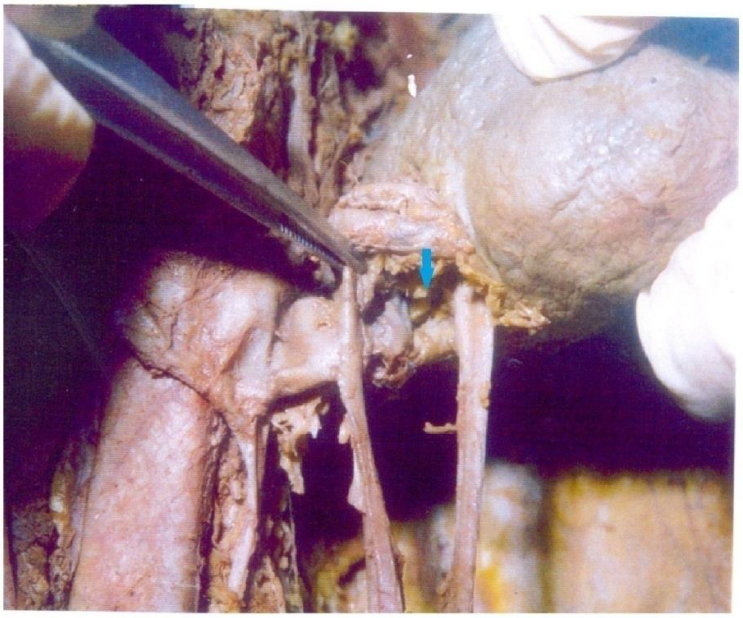


BIFID LEFT GONADAL VEIN TERMINATION WITH ONE SEGMENT ENTERING CAUDAL BORDER AND ANOTHER LOWER ANTERIOR TRIBUTARY

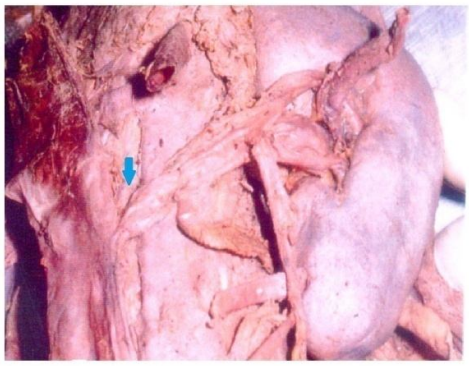


POSTERIOR VIEW:RETROPELVIC VENOUS TRIBUTARY(➡)AND ARTERIAL BRANCH

DOUBLE RIGHT RENAL VEIN



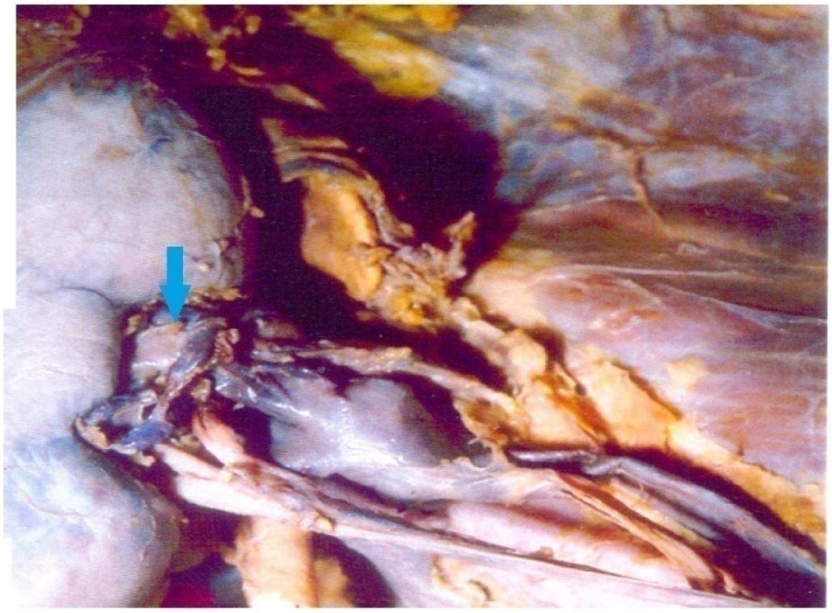
POSTERIOR TRIBUTARY DIVIDING INTO PREPELVIC AND RETROPELVIC TRIBUTARIES



OBTUSE ANGLE OF LEFT RENAL VEIN TERMINATION

PERSISTENT POST RENALIVC
WITH 2 LEFT GONADAL VEINS
TERMINATING IN IT

POSTERIOR VIEW:
RETROPELVIC VENOUS
TRIBUTARY

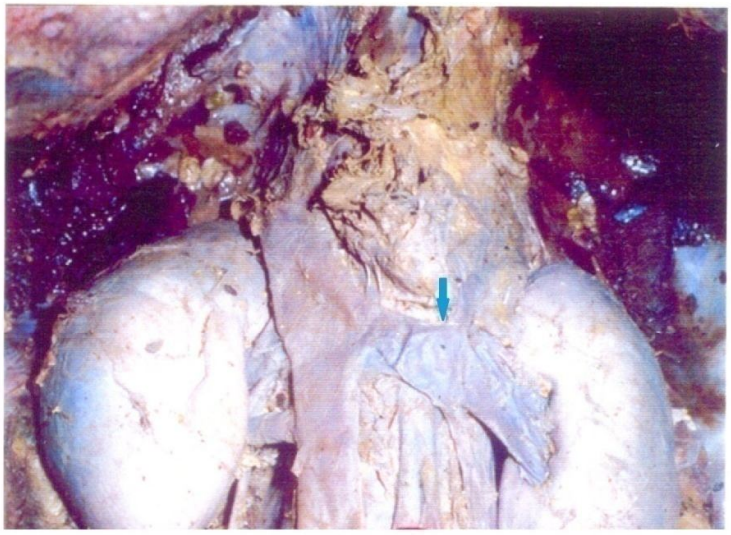


POSTERIOR VIEW:2nd LEFT LUMBAR VEIN JOINING POSTERIOR ASPECT OF LEFT RENAL VEIN .

3 INFERIOR PHRENIC TRIBUTARIES VISUALISED

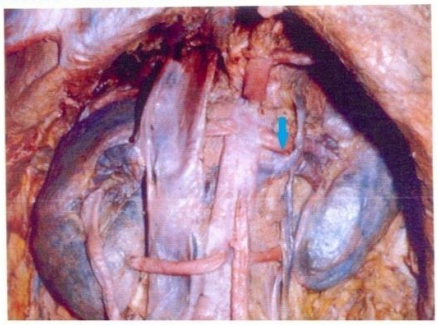
LEFT COMMON TRUNK
MEDIAL TO GONADAL VEIN
WITH RENAL ARTERY
DESCENDING TO VENTRAL
POSITION

LEFT COMMONTRUNK AND
GONADAL VEIN TERMINATING
OPPOSITE TO EACH OTHER
DOUBLE RIGHT RENAL VEIN

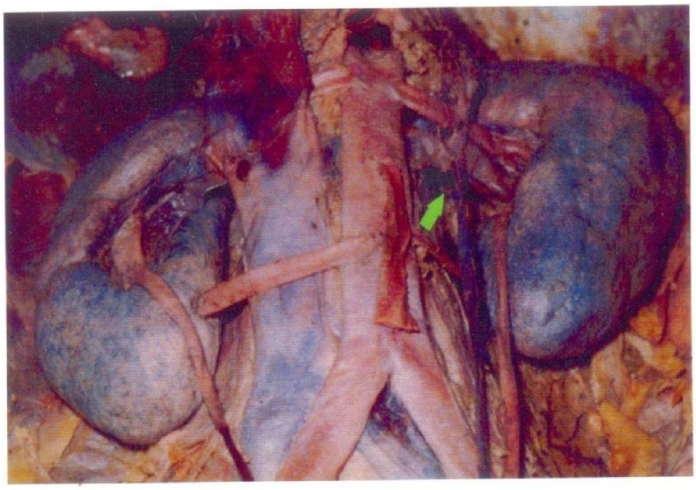


POSTERIOR VIEW:
RETROPELVIC POSTERIOR
TRIBUTARY WITH 2nd LEFT
LUMBAR VEIN
TERMINATING IN IT WITH
A VENOUS LOOP
CONNECTING GONADAL
AND RETROPELVIC
TRIBUTARY

RETROAORTIC LEFT RENAL VEIN

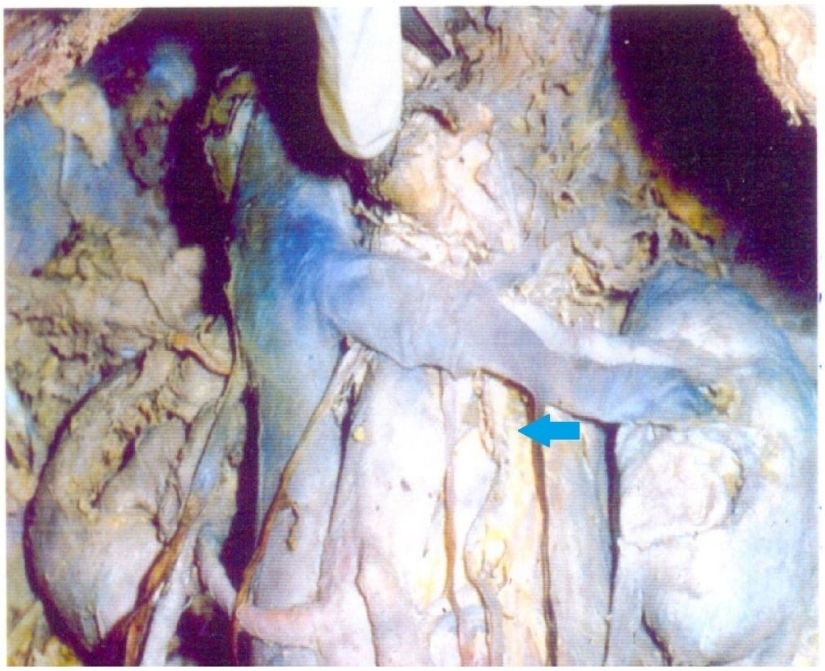


2nd LEFT LUMBAR ENTERING DORSAL ASPECT OF LEFT GONADAL VEIN

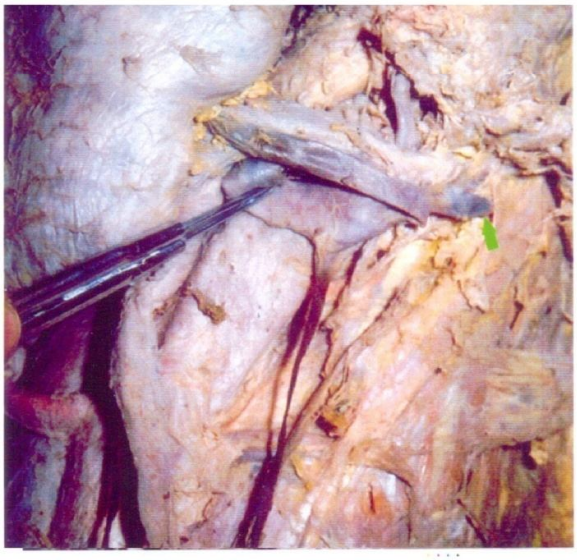


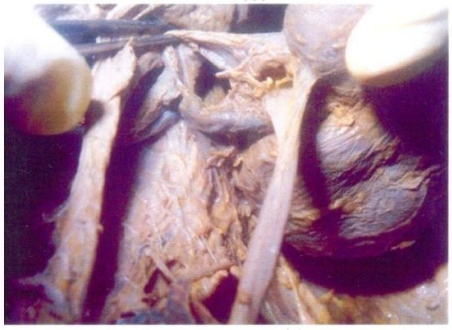
CLOSER VIEW:NON ROTATED KIDNEY WITH DOUBLE RENAL VEIN ON THE RIGHT, BILATERAL DOUBLE RENAL ARTERY LEFT COMMONTRUNK AND GONADAL TERMINATING OPPOSITI TO EACH OTHER

3 LEFT GONADAL VEINS TERMINATING IN LEFT RENAL VEIN.



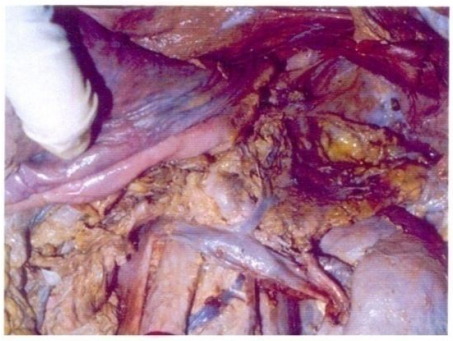
RETROPELVIC POSTERIOR TRIBUTARY WITH 2nd LEFT LUMBAR VEIN



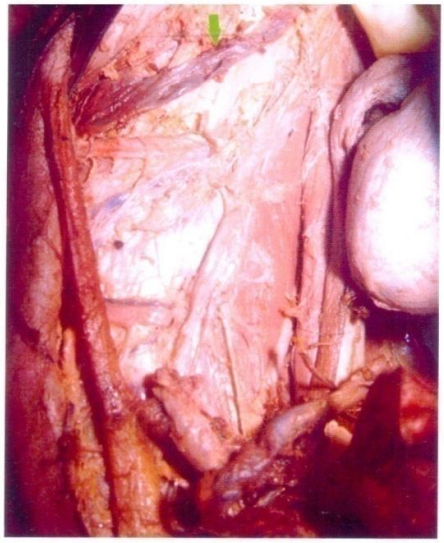


CLOSER VIEW :
SHOWING ANTERIOR AND
POSTERIOR TRIBUTARIES

POSTERIOR VIEW:
RETROPELVIC POSTERIOR
TRIBUTARY WITH 2nd LEFT
LUMBAR VEIN TERMINATING
IN IT

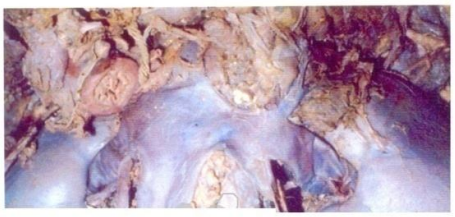


ENLARGED 2ND LEFT LUMBAR VENOUS TRIBUTARY



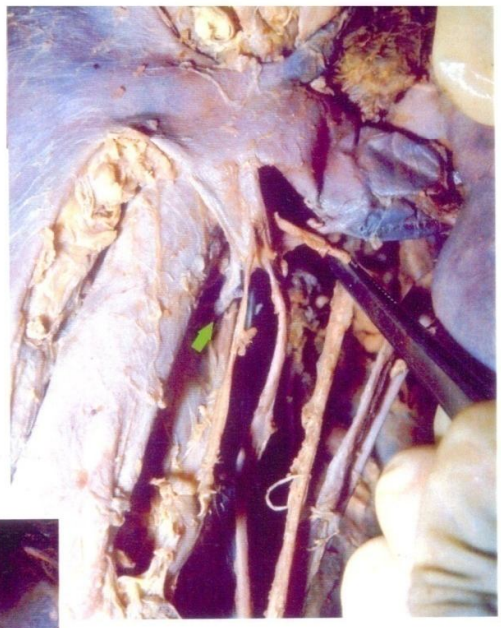
ENLARGED 2nd LEFT LUMBAR VENOUS TRIBUTARY COMMUNICATING WITH POSTERIOR ASPECT OF LEFT RENAL VEIN

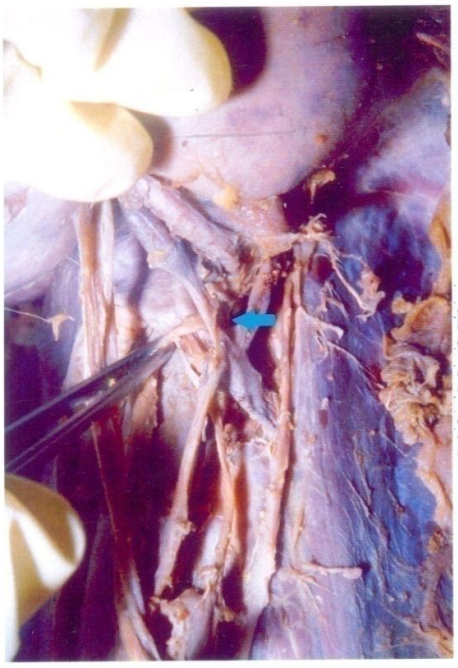
(⬅ COMMUNICATING POINT)



LEFT GONADAL ARTERY TRAVERSING THROUGH HIATUS IN CAUDAL BORDER OF LEFT RENAL VEIN

CLOSER VIEW:ASCENDING LEFT LUMBAR VENOUS CHANNEL JOINING LEFT RENAL VEIN



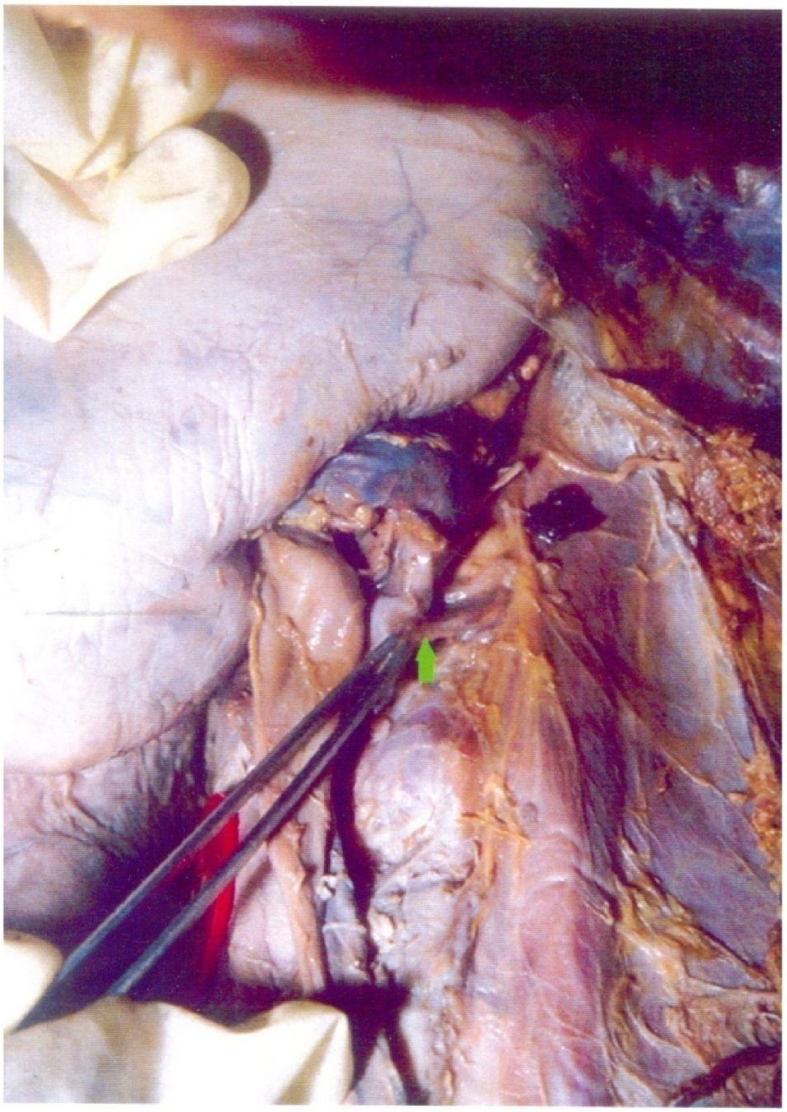


POSTERIOR VIEW: RETROPELVIC VENOUS TRIBUTARY WITH 2nd LEFT LUMBAR VEIN JOINING IT AND RETROPELVIC ARTERIAL BRANCH

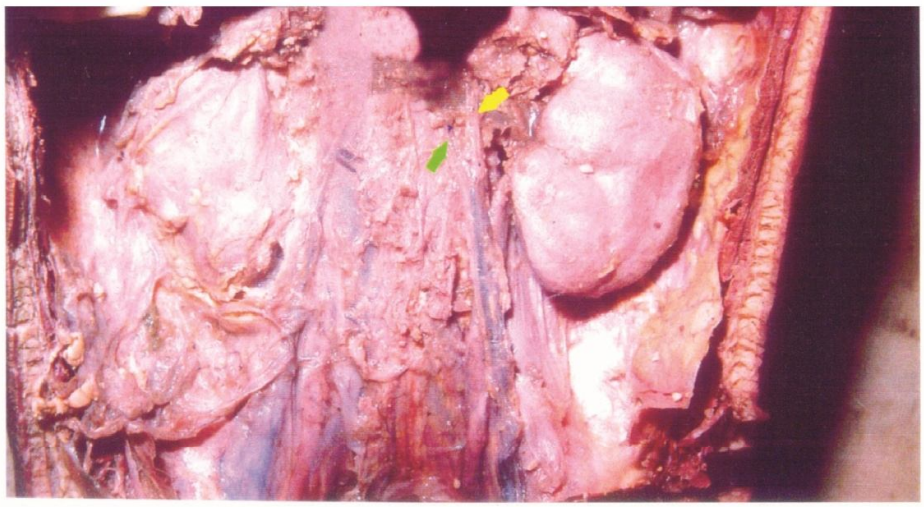
RETROAORTIC LEFT RENAL VEIN

DOUBLE LEFT RENAL ARTERY

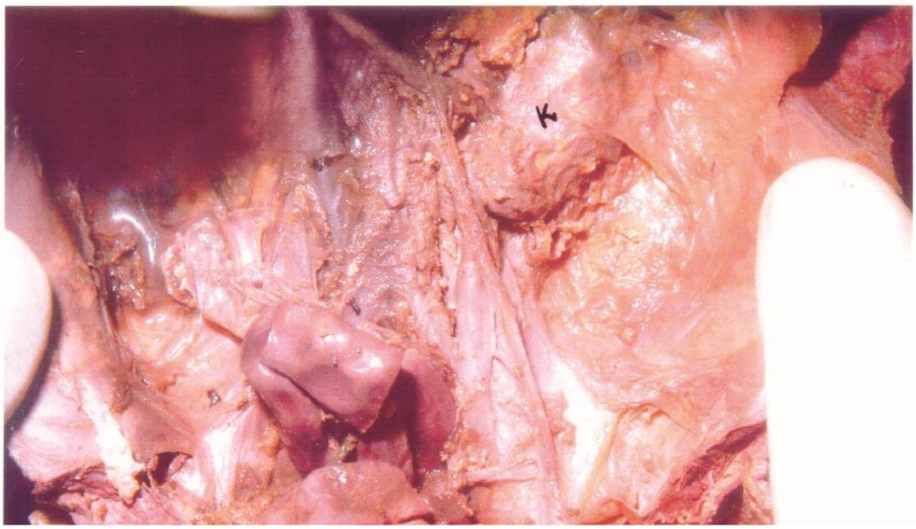
RIGHT CONTRATED KIDNEY WITH DOUBLE ARTERIES



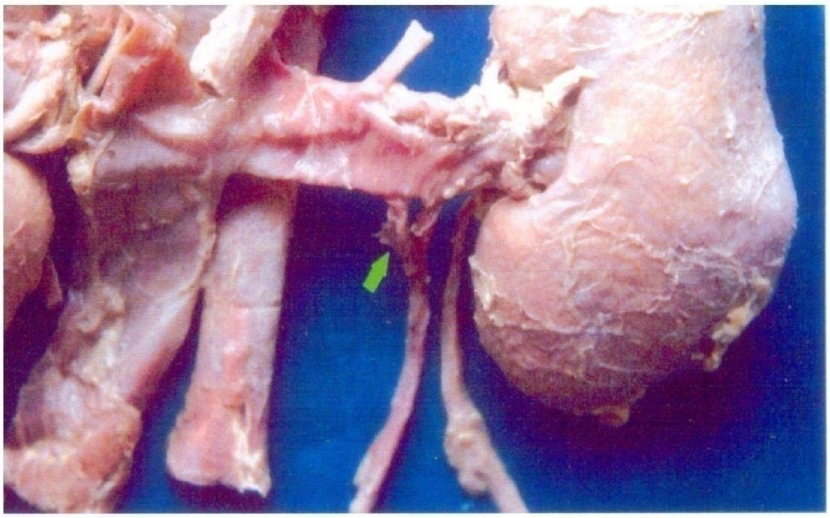
POSTERIOR VIEW: RETROPELVIC VENOUS TRIBUTARY WITH 2nd LEFT LUMBAR VEIN JOINING IT



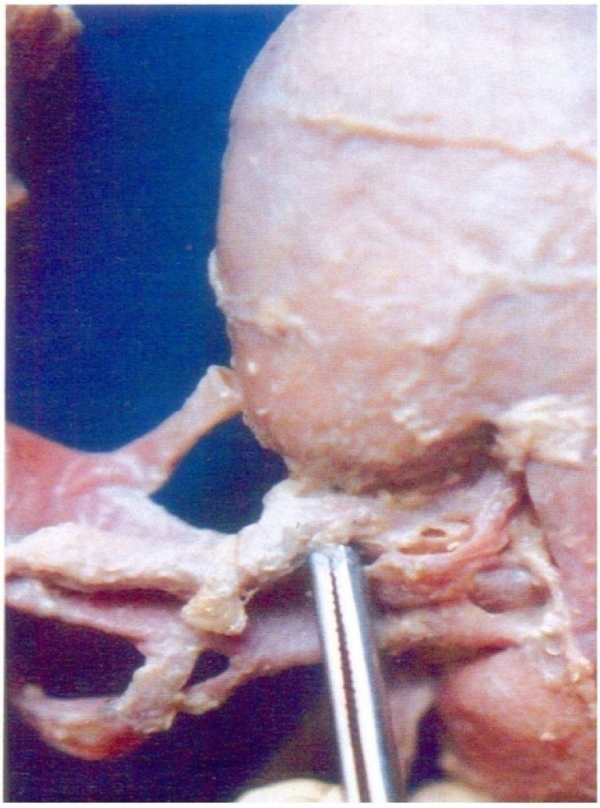
BIFID LEFT GONADAL VEIN (➡) TERMINATION WITH GONADAL ARTERY (➡) HOOKING OVER LEFT RENAL VEIN



LEFT SUPRARENAL MEDIAL TO GONADAL VEIN WITH RENAL ARTERY DESCENDING TO VENTRAL POSITION



BIFID LEFT GONADAL VEIN TERMINATION

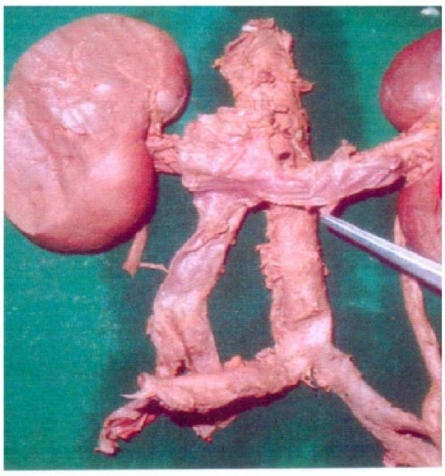


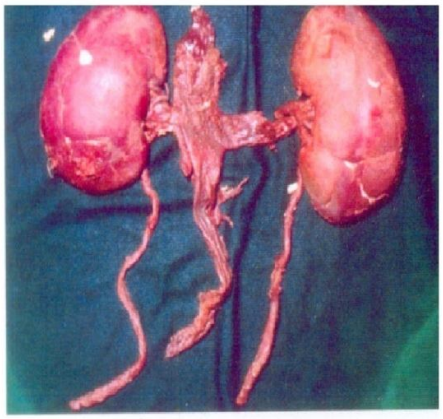
CLOSER ANTERIOR VIEW:
2ANTERIOR TRIBUTARIES CONFLUENCE FORMING
LEFT RENAL VEIN

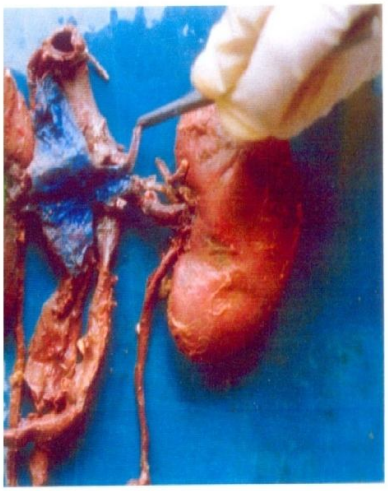
LOBULATED LEFT KIDNEY
WITH LEFT RENAL VEIN

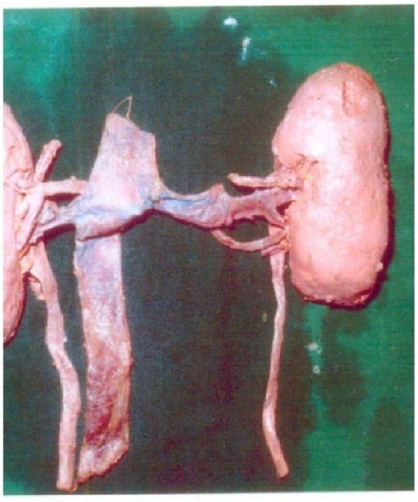
LOBULATED KIDNEY
WITH LEFT GONADAL
JOINING SUPRARENAL
AT CRANIAL BORDER
IN COMMON
TERMINATION (➡)

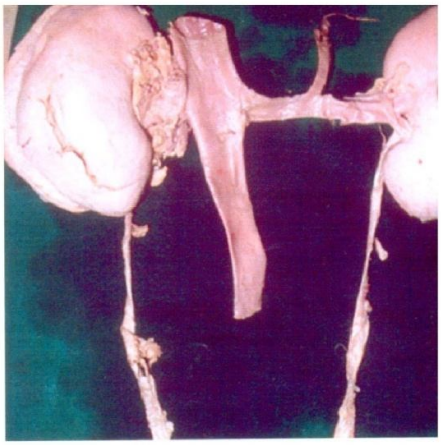
LOBULATED LEFT KIDNEY
WITH LEFT RENAL VEIN

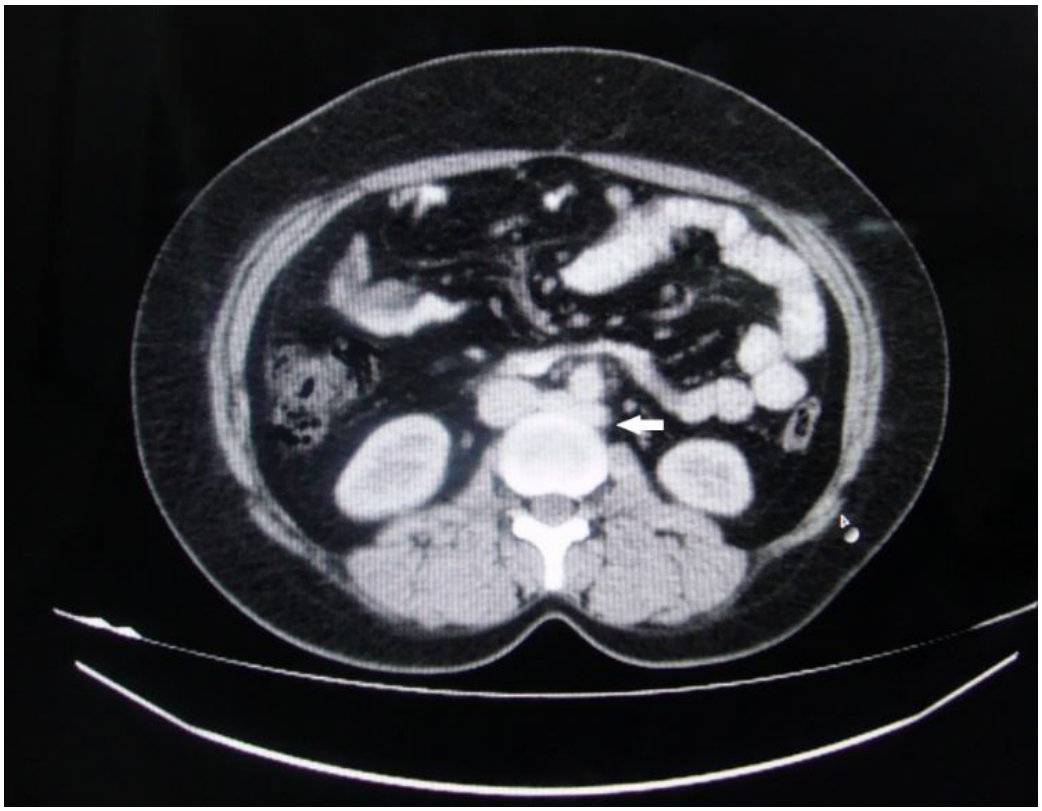












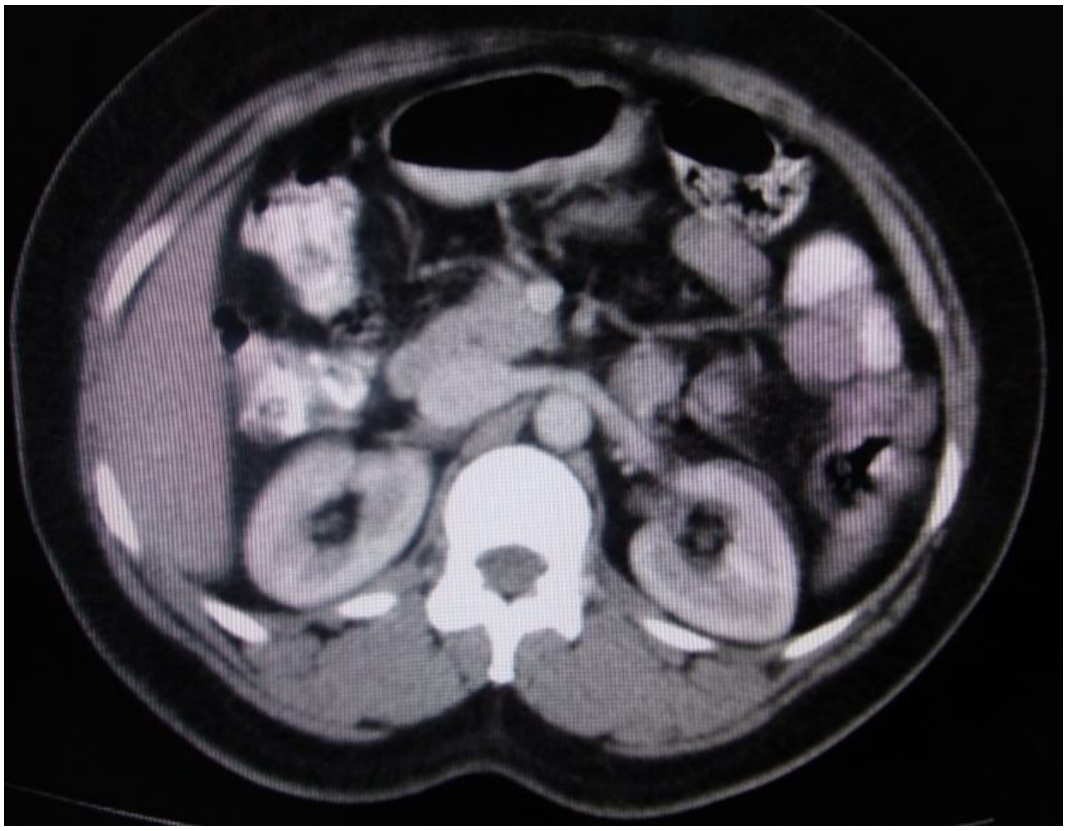
AXIAL VIEW SECTION OF 4 SLICE COMPUTED TOMOGRAPHY

SHOWS: RETRO AORTIC LEFT RENAL VEIN (WHITE ARROW)

WHICH PASSES POSTERIOR TO AORTA.

CONTRAST ENHANCED

BILATERAL KIDNEYS AND BOWEL LOOPS ARE SEEN.



CONTRAST ENHANCED CT PICTURE SHOWS NORMAL DRAINAGE OF

LEFT RENAL VEIN WHICH PASSES PRE AORTICALLY, THAT PASSES

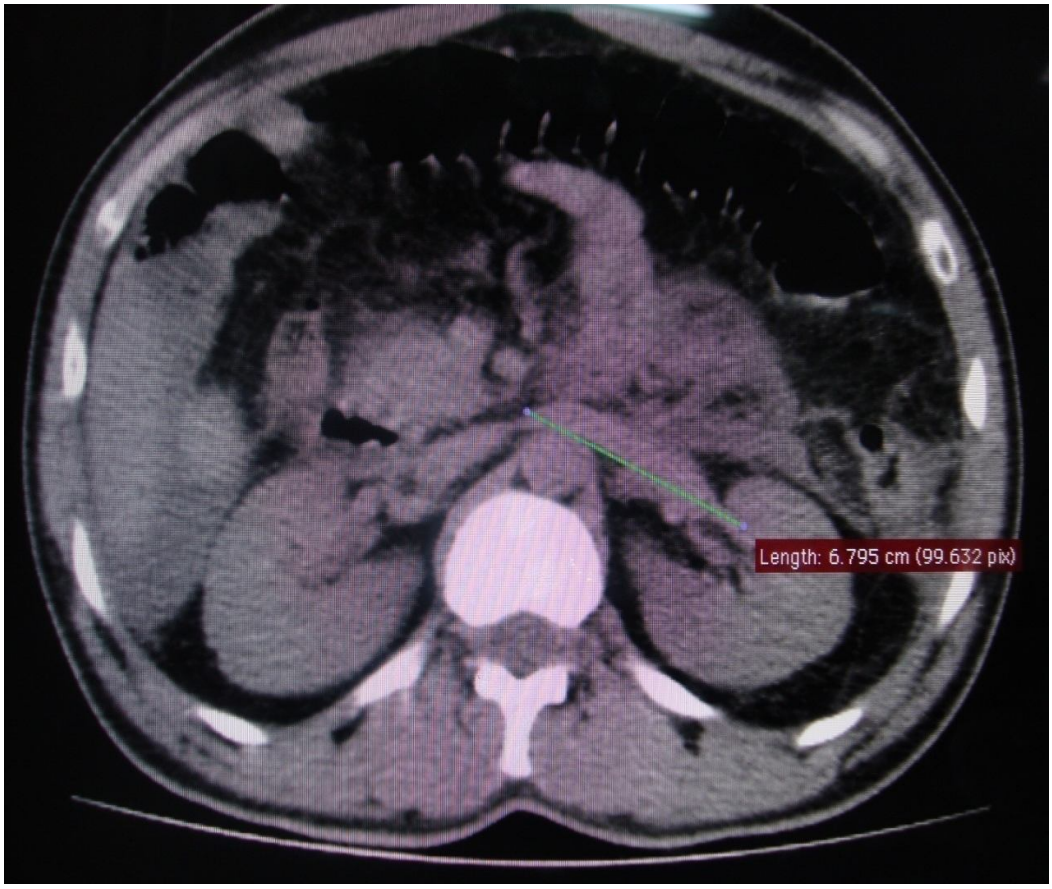
POSTERIOR TO PANCREAS AND JOINS THE INFERIOR VENA CAVA.

CORONAL MDCT RECONSTRUCTION WAS DONE AND THE ANGLE

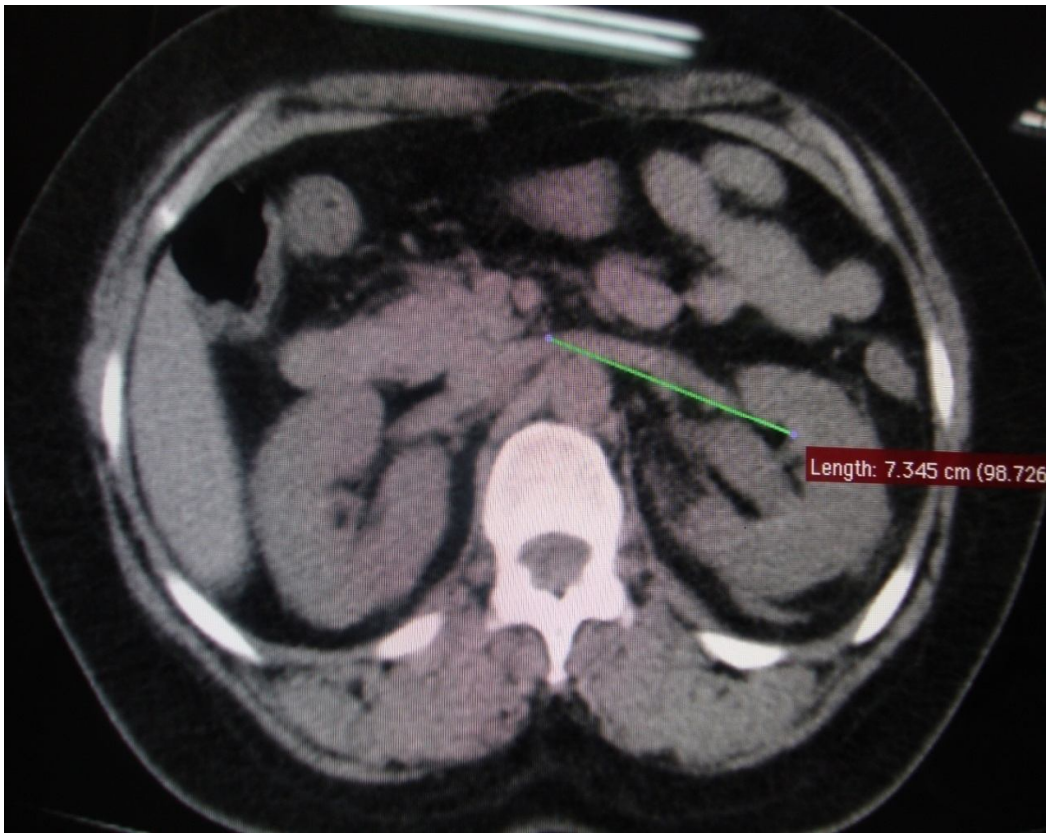
BETWEEN THE LEFT RENAL VEIN WITH INFERIOR VENA CAVA WAS

MEASURD USING THE ANGLE MEASUREMENT TOOL.


Angle: 97.319 / 262.681



WITH AXIL VIEW OF CT THE LENGTH OF LEFT RENAL VEIN WAS MEASURED USING THE LINEAR MESUREMENY TOOL.


Length: 7.345 cm (98.726

DISCUSSION

Various anatomically, radiologically and surgically valued parameters and variations of left renal vein that were observed, were analysed and put on stand for a comparative trial with extensive work done by many previous eminent people.

1. Pattern of confluence of tributaries forming left renal vein:

ElSENDRATII (1920)[27] observed left renal vein formed from equal sized anterior and posterior tributary in 3 out of 218 kidneys studied (1.3%).

PICK J.W., et al (1940)[76] described formation of left renal vein by confluence of 2 hilar tributaries.

RUSSELL. T. WOODBURNE A.M, (1957)[88] described that both anterior and posterior tributaries contribute to form left renal vein.

R.J. LAST, (1990)[64] described left renal vein being formed by confluencc of 5 - 6 renal venous tributaries.

K.S.SATYAPAL, (2003)[91] classified and gave incidence on type of drainage of left renal vein in 306 kidneys as,

Type I A+B - 38.6%,

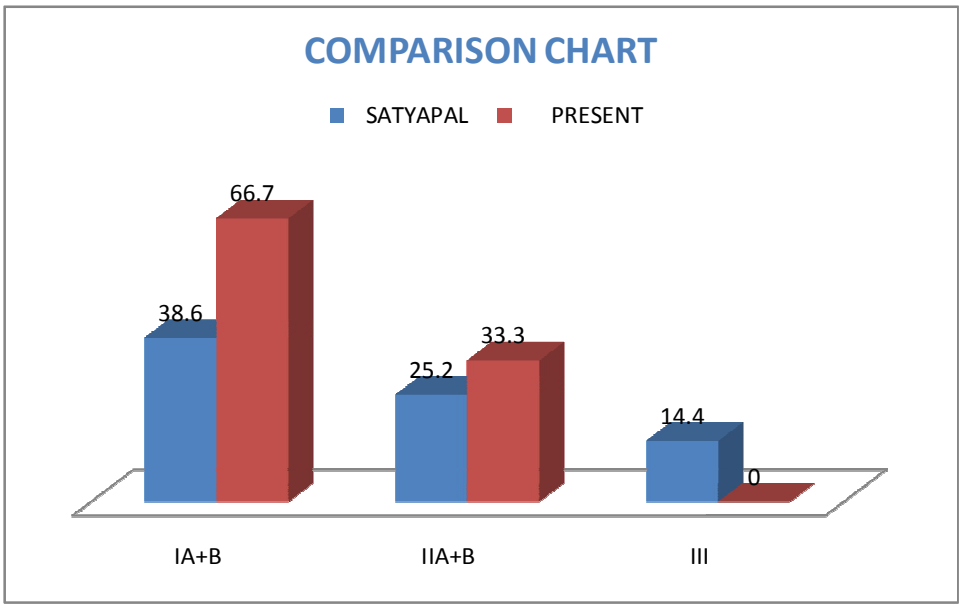
Type II A+B - 25.2%,

Type III - 10.1 - 14.4%

PRESENT STUDY shows incidence of

(i) 10% of equal sized anterior and posterior tributaries forming left renal vein differs widely from EISENDRATH'S incidence.

(ii) Formation left renal vein by the Union of 2 tributaries – 43.33%, Union of 3 tributaries – 36.7%, Union of 4 tributaries - 20%, Union of 5 tributaries Nil, which differs slightly from RENAN'S incidence and differs significantly from SATYAPAL'S incidence.



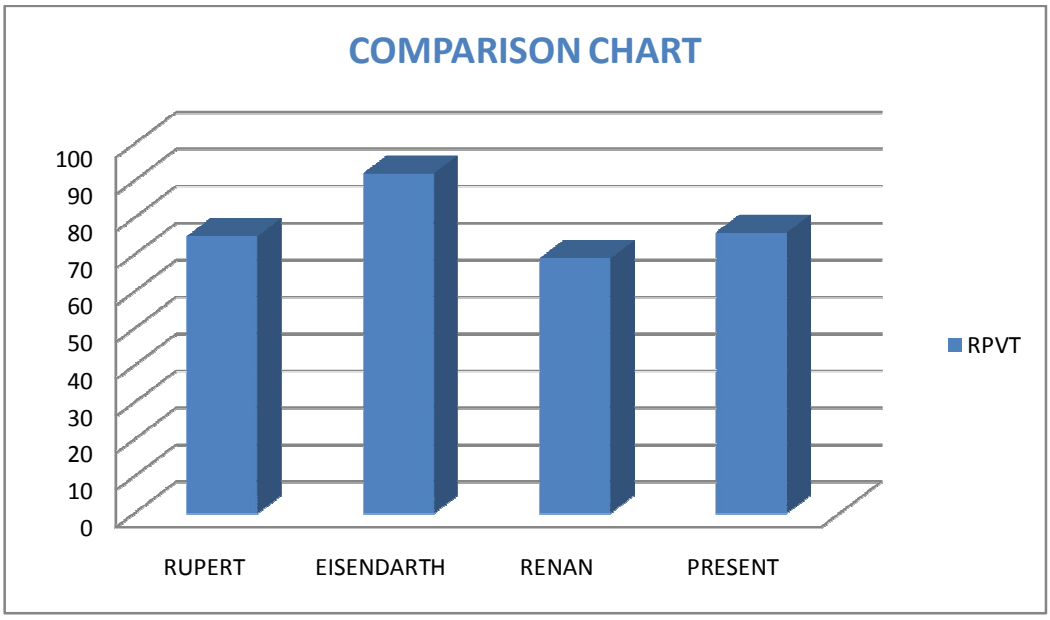
II. Incidence of Retropelvic Venous tributary / Vein: (with added reference to retropelvic arterial branch / artery) forming left renal vein.

RUPERT, (1913)[87] gave an incidence of 22 out of 30 for retropelvic venous tributary to left renal vein. (75%)

EISENDRATH, (1920)[27] gave an incidence of 201 out of 218 (92.2%) to have either a retropelvic venous tributary / vein of which 86.2% had an artery accompanying it.

RENAN UFLACKER M.D., (1997)[83] put forth the occurence of retropelvic venous tributary / vein as 36 out of 52 (69.2%)

PRESENT STUDY shows the Incidence of 23 out of 30 (76%) to have a retropelvic venous tributary / vein and 24% to have retropelvic arterial branch, is nearer to RUPERT'S incidence, widely differs from E. HAUCH and RENAN, grossly from EISENDRATH.



III. Mode of termination of left suprarenal vein and left inferior phrenic vein in to left renal vein.

J. EARNEST FRAZER, REGINALD H., (1937)[31] stated that usually left suprarenal and left inferior phrenic forming a common trunk before draining into left renal vein.

BARRY J. ANSON and LE ROY E. KURTH, (1955)[8] observed left suprarenal and left inferior phrenic confluences on their way to join left renal vein in 25 out of 33 specimens (75.75%).

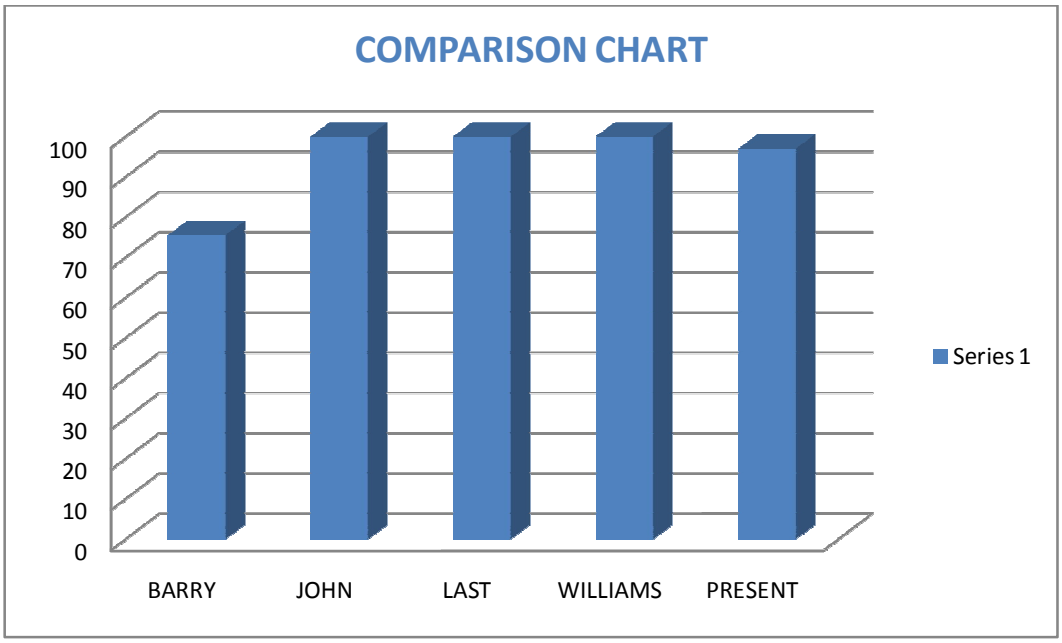
F.R.C. JOHNSTONE. (1957)[53] found left suprarenal and left inferior phrenic vein confluenced in all the 10 fresh cadavers he studied.

BARRY J. ANSON and EDWARD H. DASELER, (1961)[7]stated from observation of 100 specimens that left suprarenal vein either directly or by means of common stem with left inferior phrenic entered left renal vein.

R.J. LAST, (1990)[64] stated that left renal vein receives left suprarcnal and lelt gonadal vein and possibly left inferior phrenic vein.

WILLIAMS, (1995)[101] stated that left suprarenal usually with one left inferior phrenic vein entered left renal vein.

PRESENT STUDY: Impression of common trunk formation coincides with observations of all the previous authors and differs slightly from BARRY and KURTH'S observation.



IV. Mode of termination of left gonadal vein in to left renal vein.

PICK and ANSON, (1940)[76] stated single left gonadal vein terminating caudally in the left renal vein as the commonest mode and double left gonadal vein as a rare phenomenon.

BARRY J. ANSON and LE ROY E. KURTH, (1955)[8] observed that the frequent mode of termination being single in caudal border. They also mentioned instances of left gonadal vein being bifid or double throughout its course and one instance of left gonadal vein terminating with left suprarenal vein out of 33 studied.

R.J. LAST, (1990)[64] and WILLIAMS et al., (1995)[101] stated that single left gonadal vein terminates in the caudal border of left renal vein.

KIANG - HIONG TAY et al., (2002)[57] concluded from their experiences in performing varicocele embolisation in 18 patients that left spermatic vein's termination varied from patient to patient.

AUGILAR RIVILLA E. et al., (2002)[3] observed one instance of left gonadal vein terminating in preaortic limb along with left common trunk in circumaortic venous ring while doing embolisation of varicocele.

THE PRESENT STUDY shows a single vein terminating in caudal border with infrequent bifid and double terminations and rare termination of left gonadal vein with common trunk coincides with all.

V. Relation of the termination of left common trunk to left gonadal vein with reference to left renal vein.

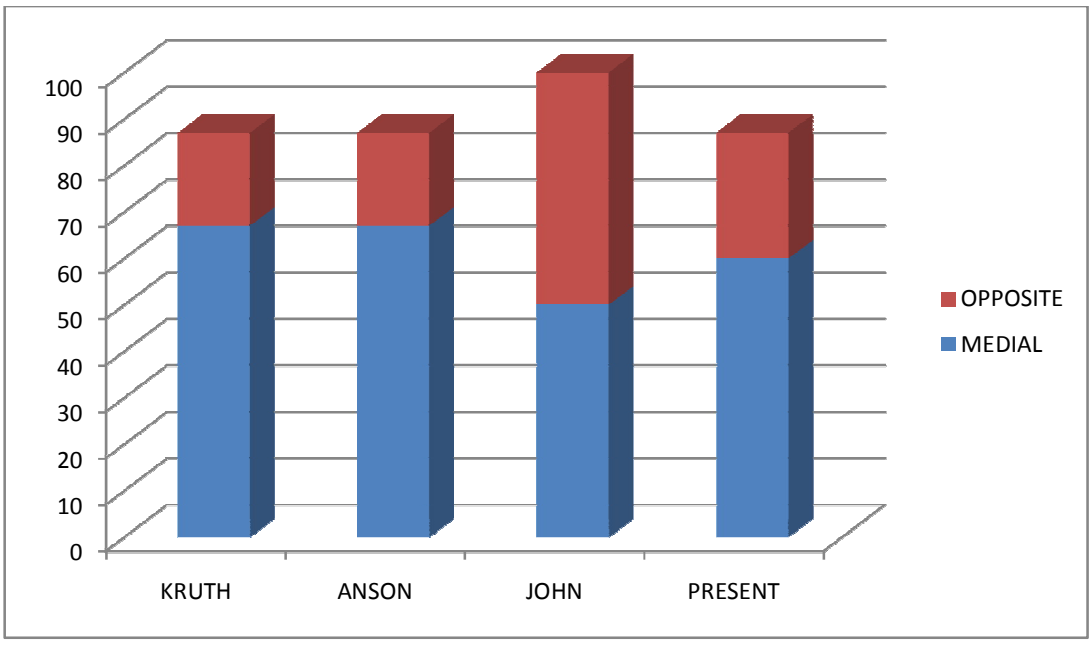
BARRY J. ANSON and LE ROY KURTH, (1955)[8] Pointed out that termination of left common trunk was frequently medial to left gonadal and infrequently opposite to each other and rarely lateral.

F.R.C. JOHNSTONE, (1957)[53] observed in 10 cases the relation of the termination of left common trunk to left gonadal vein as equally distributed among medial and opposite positions.

BARRY J.ANSON and EDWARD H. DASELER, (1961)[7] stated from their study of 100 specimens that left gonadal vein terminated usually lateral to left common trunk.

WILLIAMS et al., (1995)[101] in Gray's Anatomy stated that left suprarenal usually with one of left inferior phrenic entered the left renal vein nearer the midline from above, while the left gonadal entered from below.

PRESENT STUDY the left common trunk terminating medial to left gonadal vein is common and less frequently opposite to each other which is similar to observations of BARRY and KRUTH'S, BARRY and CAULDWELL'S. It differs from WILLIAMS et al's statement.



Vl. Distance of point of termination of left suprarenal / common trunk from left margin of Inferior vena cava:

D. EMERICK SZILAGYI et al., (1964 - 68)[28] performed severance of left renal vein at a point midway between emptying of left suprarenal and termination of left renal vein in 20 out of 551 aortic surgeries.

ERLIK et al., (1965)[29,30] did left renal vein division at a distance with in 5 - 6cm from IVC's left margin.

DOMINIC A DELAURENTIS, et al., (1970)[23] did ligation of left renal vein to the right of left suprarenal termination in 4 patients.

PAUL D. DEARING, et al., (1990)[75] performed left renal vein division close to confluence with IVC.

KEITH D. CALLIGARO, et al., (1990)[56] performed division of left renal vein approximately 1cm from its junction with IVC.

R.J. LAST, (1990)[64] and WILLIAMS et al.,(l995)[101] in Grays anatomy stated that the left renal vein could be ligated safely to the right of left suprarenal termination.

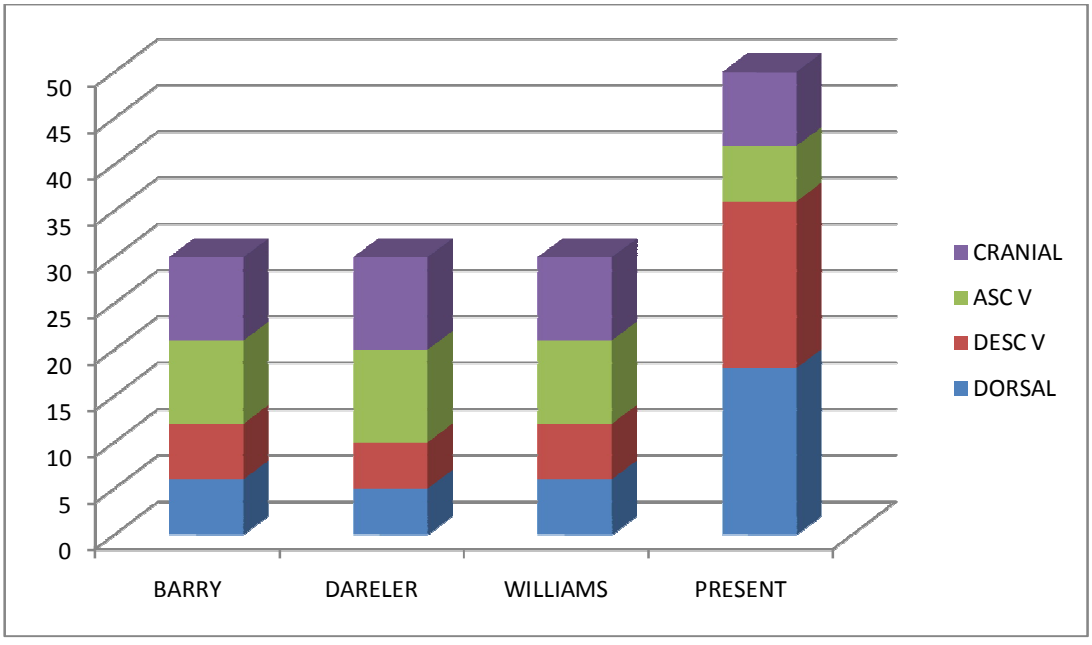
PRESENT STUDY shows the safe margin for ligation of 2.5cm from left margin of inferior vena cava coincides with the safety limits of ligation practised by all previous authors except with ERLIK et al.

VII. Relation of left renal artery to left renal vein:

BARRY J ANSON and EDWARD H. DASELER, (1961)[6] gave incidence of left renal artery's relation from 125 specimens as, Dorsal to vein -61 (4.76%), Descending to ventral position- 51 (42%), Ascending to ventral position - 3 (2.4%), No relation to vein 10 (8%), concluding that dorsal to vein as the commonest.

WILLIAMS et al., (1995)[101] in Gray's anatomy stated left renal vein being anterior to left renal artery.

PRESENT STUDY the relation of left renal artery's position of : Dorsal to vein- 36%, Descending to ventral - 36%, Ascending to ventral 12%, Cranial with no relation - 16% differs from BARRY, DARELER'S, and WILLIAM'S by having an equal incidence for dorsal and descending to ventral position and in having higher incidence for ascending to ventral and cranial positions.



VIII. Incidence of left renal vein variants:

Many authors have reported about variations of left renal vein and so their incidences are being formatted into a tabulation along with incidence of present study and presented.

S.No	Author (cases studied)	Year	Circumaortic	Retroaortic
1.	Pick.J.W & B.J.Anson (430)	1940	0.4%	0.2%
2.	Richard A. Davis et al (100)	1958	6%	2%
3.	Raymond.H.Reis et al (500)	1959	6%	2.4%
4.	Brener et al (31)	1974	6.4%	2.8%
5.	Carl.F.Beckmann et al (127)	1979	11%	3.7%
6.	Reed et al (433)	1982	4.4%	1.8%
9.	Martinez Almagro et al (286)	1992	-	6%
10.	Hicks et al (108)	1995	11%	1.8%

11.	Coll et al (69)	1999	4.3%	-
12.	Shindo.S et al (166)	2000	0.6%	-
13.	Aguilar Rivilla.E.et al (101)	2002	4%	-
14.	K.S Satyapal (50)	2003	0.3%	0.5%
15.	Balci et al (140)	2007	-	9.3%
16.	Present study (50)	2012	6%	4%

Present study's incidence of circumaortic left renal vein is consistent with incidence quoted by most of the authors except with PICK and ANSON'S, REED'S, COLL'S, SHINDO S'S, K.S. SATYAPAL'S, AGUILAR RIVILLA E 'S who gave lower incidence that too especially PICK and ANSON, SHINDO S and K.S. SATYAPAL whose incidence were very low

IX. Length of left and right renal veins:

BARRY J. ANSON and EDWARD A. DASELER., (1961)[6] gave the length of right renal vein: 20 - 45mm (Avg 34mm), left renal vein: 60 mm -110mm (Avg 84mm) and stated that left is greater than right by 2.5 times, out of 30 specimens studied.

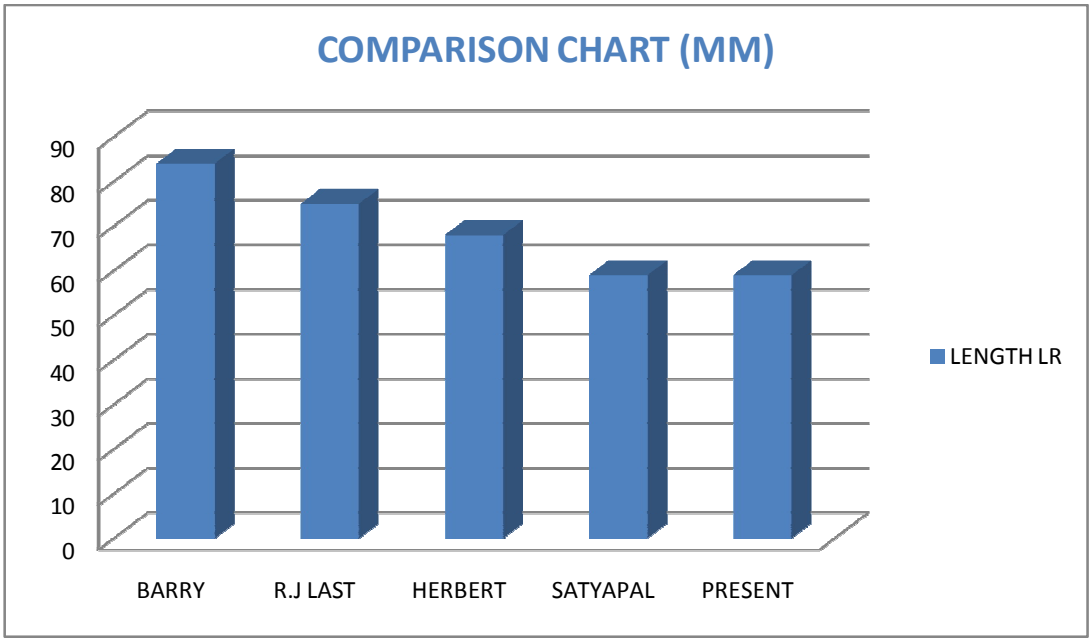
R.J.LAST, (1990)[64] and WILLIAMS, et al., (1995)[101] in Gray's Anatomy, described left renal vein - 7.5 cm, right - 2.5cm and inferred that left renal vein is greater than right renal vein by 3 times.

HERBERT L. ABRAMS, (1983)[1] from his study of 76 left renal venograms provided average length of left renal vein as 68mm (with a range of 35- 100mm.

K.S.SATYAPAL, (2003)[91] presented length of left renal vein as 5.9 + 1.5cm and right renal vein as 2.4 + 0.78cm and concluded that left is greater than right by 2.5 times from his study of 100 specimens.

PRESENT STUDY : the average length of left renal vein is 5.9cm (2.4 - 9.4cm) and right renal vein is - 2.4cm (0.9 - 4.5cm) and it shows the left renal vein is greater than the right renal vein by 2.1 times, is consistent with statement of K.S.SATYAPAL. Differs mildly with HERBERT L.

ABRAMS and BARRY J. ANSON & EDWARD H. DASELER'S and markedly with R.J. LAST and WILLIAMS et al's., in having a lower value.



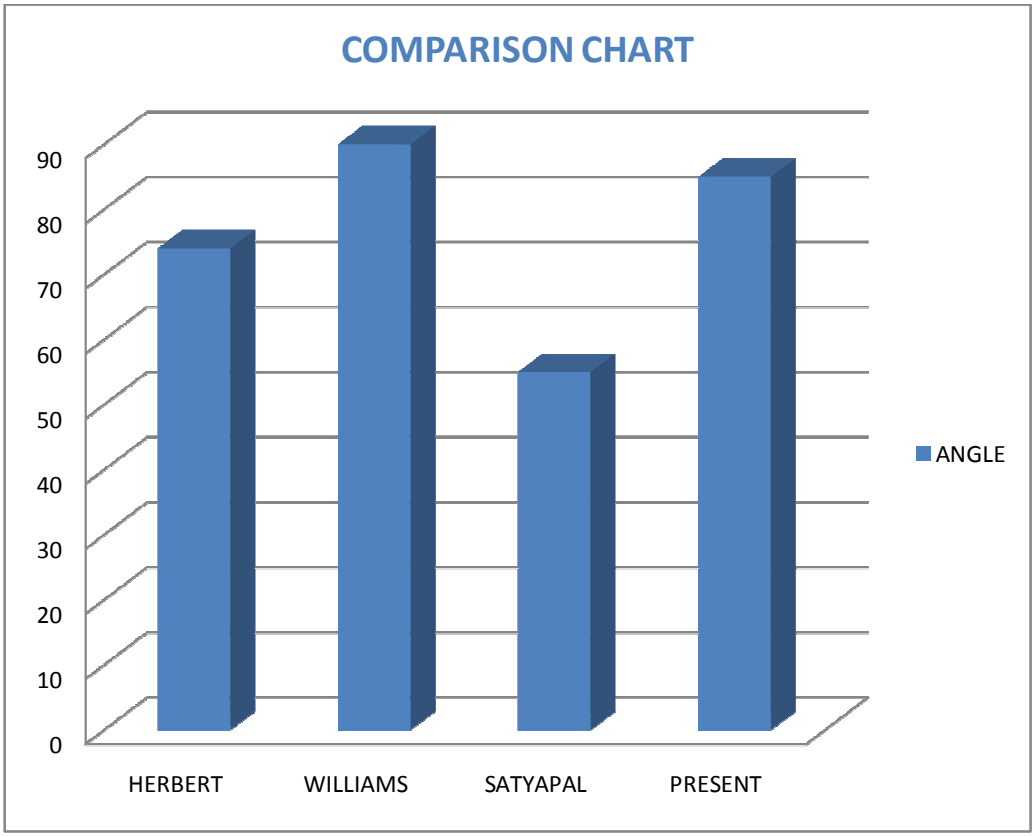
X. Angle formed between left renal vein and inferior vena cava:

HERBERT L. ABRAMS, (1983)[1] from his study of 76 left renal venograms gave, average left infra renal angle as 74°(25 - 105°).

WILLIAMS et al., (1995)[101] in Gray's Anatomy stated that left renal vein opened into IVC at 90.

K.S.SATYAPAL, (2003)[91] gave from his investigation of 100 specimens 32 venograms, infrarenal angle on left as 55° (20- 102°)

PRESENT STUDY: the angle formed between left renal vein and inferior vena cava, range for (58 - 113°) and average is 84.8° coincides with HERBERT L. ABRAMS and WILLIAMS et al's report and grossly differs from K.S.SATYAPAL'S inference.



CONCLUSION

The clinical importance of left renal vein is as follows:

The major role in renal transplantation is the limelight as the left side is the preferred site for donor nephrectomies.

The knowledge of classification of types of renal venous drainage pattern has surgical and uro-radiological relevance especially in assisting renal angiographers for, selective segmental vein renin assay sampling.

The awareness about the presence of retropelvic tributary and / or branch gains important for the urologist during open / laproscopic pyelotomy, pyeloplasty to prevent accidental injury to these structures.

The anatomy of termination of left suprarenal vein is important during left adrenal vein catheterization and adrenal hormonal assaying.

The knowledge of termination of left gonadal vein is significant to interventional radiologist for doing varicocele embolization procedures and also for surgeons.

Ligation of left renal vein is done during aortic aneurysmal and other aortic repair surgeries, in order to gain clear access to aorta while repairing it and so the knowledge of safe limit for ligation is important for vascular surgeons to enable them in avoiding accidental injury to tributaries and collateral circulating channels of left renal vein.

Left gonadal artery crossing over the renal vein may be a possible etiological factor for idiopathic varicocele in male and / or orthostatic albuminuria, pelvic varicocele (ovarian (or) broad ligament varicocele) in females, due to compressive effect of it.

Prior knowledge of left renal venous variations are important for vascular surgeon, retroperitoneal surgeon, urologist and radiologist so that accidental injury during surgery or missing of the variations during imaging could be avoided.

Compression of left renal vein by superior mesenteric artery and abnormal course results in nutcracker phenomenon, results in haematuria, hypertension and pain in abdomen.

Compression of gonadal vein results in pelvic congestion syndrome in females, and varicocele in males.

As previously pointed out in discussion , there occurs a considerable variation in incidence of certain significant morphological and morphometric parameters of left renal vein, when compared to textbook standards and previous studies and so,

The present study which is done without haste and so, it makes the possibility of demonstrating anatomical structures in detail which are not done easily during the surgical procedures.

It warrants recognition of these prior knowledge to many therapeutic and research decisions.

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